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1961 No. 4 COPEIA December 19

The Life History and Systematics of *Ambystoma rosaceum*

JAMES D. ANDERSON

TAYLOR (1941) described *Ambystoma rosaceum* on the basis of two larvae collected by I. Knobloch at Mojarachic, Chihuahua (see Riemer, 1954, for a discussion of this locality). In 1951 Shannon reported on additional larval specimens from Durango and Sonora, describing these as new subspecies, respectively *A. r. nigrum* and *A. r. sonoraensis*. The subspecies *nigrum* was known only from the holotype (USNM 123581) whereas *sonoraensis* was based on four larvae, two being "too small and too poorly preserved to be of much diagnostic value." Taylor (op. cit.) considered *rosaceum* as a neotenic species but Shannon (1951:489) later indicated that *A. r. sonoraensis* might transform. Aside from the general comments on the possible relationships of this species by Tihen (1958) there have been no further reports on *rosaceum* in the literature.

The present review is based mainly on specimens in the Museum of Vertebrate Zoology, University of California (MVZ) consisting of 25 metamorphosed adults and approximately 100 larvae. In addition I have examined specimens from the United States National Museum (USNM), the American Museum of Natural History (AMNH) and the University of Kansas Natural History Museum (KU).

Acknowledgments.—I wish to thank William J. Riemer for drawing my attention to the metamorphosed adult *rosaceum* and for encouraging this study. My thanks are also due to the following persons for making specimens and information available to me: Doris Cochran, Charles M. Bogert, John Legler, Robert Webb, John Davis and Richard G. Zweifel. Gene M. Christman prepared the illustrations. Robert C. Stebbins kindly read the manuscript and offered constructive criticism.

Description of Adults

For convenience one specimen is described in detail followed by comments on variation in 21 sexually mature specimens (11 males, 10 females) from the vicinity of La Cuidad, Durango; newly metamorphosed and juvenal individuals will be discussed later.

MVZ 57279. An adult male collected at Neviero, 4 miles west La Cuidad, 8200 feet, Durango, on June 27, 1951.

Total length 151.7 mm.; snout-vent length 70.9 mm.; tail length 71.6 mm.; axilla-groin 34.1 mm.; head width 17.0 mm.; head length 20.6 mm.; interorbital distance 9.5 mm.; eye length 2.8 mm.; internarial distance 6.0 mm.; length of hind limb 25.6 mm.; costal grooves 11, counting one each in axilla and groin but not counting those over the limbs; vomerine teeth 52, divided into two groups of 26 by a short diastema in the midline.

Toes 4–5, moderately long; arranged in order of decreasing length, forefoot 3241, hind foot 43251. Phalangeal formula, forefoot 2343, hind foot 23453. Toes of adpressed hind limbs extend midway between wrist and elbow.

Tail slightly compressed laterally, greatest height 11.5 mm., greatest width 4.5 mm. and with a weakly developed dorsal tail fin.

Tongue fleshy, moderately broad with the lateral edges almost parallel. Plicae narrow, parallel, originating from broad posterior area and extending to the narrowly free margins.

An impressed groove runs posterio-ventrally from the posterior corner of eye, bifurcating above the angle of jaw; one branch extending down to angle of jaw, the other continuing posteriorly a short distance before becoming obscure.

The lateral line system is represented by shallow pits which form irregular paired lines, two or three pits wide on the head. The lines originate on the snout, extending posteriorly on the head medial to the nares and eyes. Behind the eyes they bend laterally at a sharp angle around the angle of the jaw where they merge with a scattered series present on the lower lip. Another group occurs as a cluster between the nares and eyes, posteriorly forming irregular lines below the eyes and eventually merging with the others over the angle of the jaws. Similar pits are found scattered over the body, being numerous on the dorsal surface and scarce on the ventral surface.

The tail is profusely supplied with glands which tend to form a ridge on the proximal

third to half of the tail. The pelvic region is also glandular. Scattered patches occur over the body with a heavy concentration forming a parotoid gland. The tail ridge and parotoid are similar to those in *Ambystoma gracile*, though neither is as well defined nor as dense.

Coloration.—This individual has almost no trace of a color pattern, being a rather uniform dark brown dorsally and a lighter sooty brown ventrally. There is a trace of spotting or mottling of a lighter color on the chin and along the lateral surface of the tail. Small light spots are vaguely indicated on the sides and arranged in a somewhat linear fashion. Most large adults are similar but in some the spots are more distinct, appearing to be a dull buff color (Fig. 1d). Some details of coloration will be discussed later.

Variation.—Meristic characters of a series of breeding adults from Neviero, 4 mi. W. La Cuidad, Durango are summarized in Table 1. Sexual dimorphism is evident, males having longer tails and shorter bodies than females, a condition prevailing in many species of *Ambystoma*. Costal groove counts averaged 11.0 (range 10–12). The vomerine

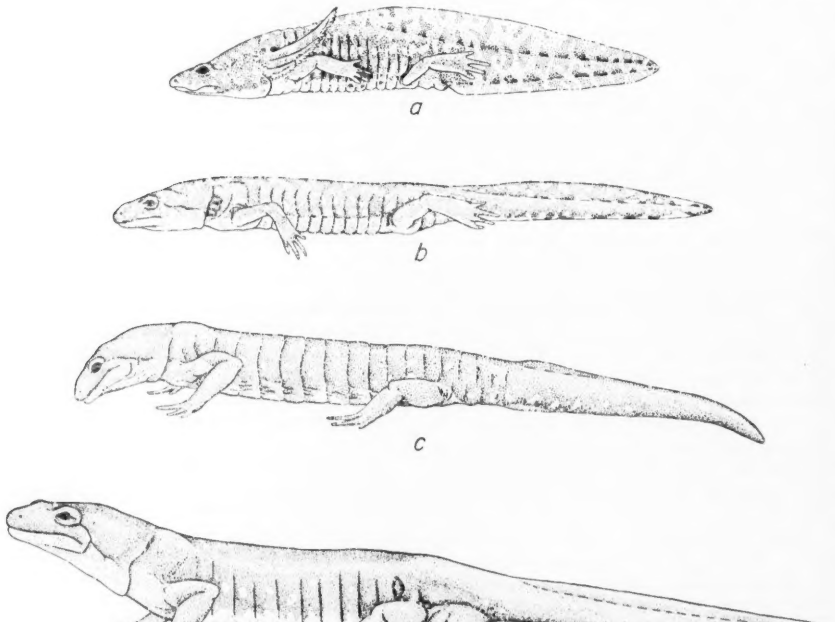

Fig. 1. Ontogenetic changes in color pattern in *Ambystoma rosaceum*.

TABLE 1. MEASUREMENTS IN MM. OF A SERIES OF BREEDING ADULT *Ambystoma rosaceum* FROM NEAR LA CUIDAD, DURANGO (MEAN ABOVE, RANGE BELOW)

	Snout-vent	Tail	Total	Tail/Total
Males N = 11	71.9 (69.2–76.6)	73.7 (69.5–75.3)	151.9 (141.9–164.4)	.464 (.433–.472)
Females N = 10	78.5 (71.1–84.8)	63.3 (55.2–71.6)	146.9 (131.1–163.5)	.430 (.403–.452)

teeth were usually in two series with a diastema in the midline. The mean number was 50.4, range 42–70.

Life History

The series of breeding adults from Neviero, a metamorphosed adult female from Colonia Garcia, Chihuahua, metamorphosed adults from the El Salto region of Durango (MVZ and KU) and newly metamorphosed juveniles from other localities in Chihuahua clearly indicate that this species regularly transforms. Examination of many larvae failed to reveal any with mature or maturing gonads.

Mating probably occurs soon after the onset of the summer rainy season, which would be any time from mid-June to mid-July in Durango and Chihuahua. The Neviero adults were collected on June 27, 1951, as they migrated to a stream for breeding. Ten females were gravid, containing large, pigmented ovarian eggs. Eleven males had the sperm ducts highly convoluted and packed with spermatozoa. Two females from El Salto, Durango, collected on June 25 and 26, 1955, were distended with ovarian and oviducal eggs. At Yaguirachic, Chihuahua, we found year-old larvae, but no eggs or breeding adults four days after the regular summer rains had begun (July 2–4, 1957), indicating that adults may not emerge until after the daily rainfall pattern is well established.

Gravid females contain approximately 200 eggs. Two females were examined; one, 77.7 mm. in snout-vent length, had 106 eggs in the right ovary, 104 in the left; the other, 71.0 mm. snout-vent, contained 110 in the right and approximately the same number in the left ovary. The ovarian eggs ranged from 2.0 to 2.7 mm. in diameter (mean 2.3 mm.) and were dark brown at the animal pole and dull yellow at the vegetal pole.

The vent region was bulbous and enlarged for breeding in all the Neviero males. A well developed cloacal gland was present, with large papillae near the cloacal lips and other smaller ones in closely set vertical rows radiating from the anterior half of the vent to the margins. The pelvic gland consists of smaller, rounded papillae which are more pigmented than those of the cloacal gland. The abdominal gland is poorly developed and only slightly differentiated from the posterior part of the cloacal roof.

As yet there is no information on courtship, oviposition, egg masses or hatching, and newly hatched larvae.

The large size of older larvae and the presence of two size groups in the same streams has led other workers to suspect that this is a neotenic species. That the larvae reach large sizes is evident from data on size at metamorphosis (Table 2), which varies as with most species of *Ambystoma*. Larvae exceeding 100 mm. total and 50 mm. snout-vent length and showing no signs of transformation are not unusual. It seems likely that a full year is required to attain such a size. A series of larvae collected 6 mi. WSW of Las Adjuntas, Durango, between July 7 and 10, 1953, falls into two size groups. The larger group of 10 animals averages 49.0 mm. in snout-vent length and several individuals have reduced gills and fins, indicating that they are in the initial stages of transformation. The smaller group averages only 33.3 mm. snout to vent (30 specimens) and shows no sign of transformation. Although it was early in the summer, the small group probably represents larvae hatched that year, whereas the metamorphosing group almost certainly represents larvae hatched the preceding year. The period when two age classes of larvae are present in the streams is probably short and would be determined by the climatic conditions of two successive years.

Length of Larval Period

From the discussion of breeding seasons it can be assumed that eggs are laid between the middle of June and early July in most years. The earliest date for metamorphosis

Table 2. Size at Metamorphosis of *Ambystoma rosaceum*

Locality	Elevation	Date	N	Mean Snout-vent Length	Mean Total Length
El Salto, Durango	9000 ft.	June 25	3	61.8	121.3
Near Las Adjuntas, Durango	8200 ft.	July 8	10	49.0	97.7
Rio Gavilan, Chih.	5700 ft.	August 6	1	48.5	98.5

is June 25, the latest August 6. Thus the larval period is at least one year and often longer. Hatching takes place rather late in summer, with little time available for growth before the onset of winter. The larvae continue to grow and probably reach metamorphic size the following rainy season. Living in permanent streams or pools, the larvae are assured of a suitable habitat from one rainy season to the next, with metamorphosis taking place at a time when temperature and moisture conditions are optimal for dispersal into the terrestrial habitat.

There may possibly be a spring breeding in some areas, controlled by factors other than rainfall. This is not indicated by present data, but is known in other species, e.g. *A. maculatum* (Blanchard 1930, Baldauf 1952).

Ontogenetic Changes in Color Pattern

The larval color pattern of this species is striking, consisting of dark and light mottling which varies considerably in intensity and configuration. It is very different from the pattern in most larval *Ambystoma* but seemingly most like that described for *A. cingulatum* (Mecham and Hellman, 1952) and *A. tigrinum* (Bishop, 1941). The descriptions and figures provided by Taylor (1941) and Shannon (1951) present the basic pattern of *rosaceum*. However, great variations exist within and between different size groups. Throughout its range the larva of *rosaceum* is a dark animal with light mottling or spotting which forms a light lateral line. Depending upon the intensity and extent of the dark color the lateral line may be narrow or wide, continuous or in a series of elongate light marks or small spots. The remainder of the body may be mottled or spotted to varying degrees with the same light color. The light areas may be small and discrete or may run together to form a secondary pattern. The secondary pattern often forms a linear series of spots above and below the lateral, light line. Most of these variations and intermediates occur within a population of similarly sized individuals. The head and tail are usually mottled, regardless of variations which exist in the trunk region. The ventral surface is generally immaculate though in dark individuals the melanophores may extend onto the lateral portions and even produce dark patches or a dark band there.

Smaller individuals tend to be more uniform in pattern, but this is in part attributable to the fact that light areas enclosed in the dark ground color are less conspicuous because of their size. The variations described above are from large larvae 35–45 mm. in snout-vent length. As they approach metamorphosis the larvae become darker and the pattern formed by the light mottling and spotting tends to become obscured. Typically the light pattern becomes a series of spots at metamorphosis. These spots may be distributed all over the body but tend to be most evident laterally, especially in the region of the primary and secondary light lines of the larval pattern. However, newly transformed *rosaceum* are even more variable than larvae. Some of this variability if directly attributable to the pattern variation which existed in the larvae, although much is due to the variation in size at which the animals transform. Those metamorphosing at a relatively small size will be lighter and tend to have a more mottled pattern, i.e., to be more like the larval pattern. Those which remain longer in the water will become darker and have the light areas reduced to spots. We know little of the sources of variation in larval features, especially those factors affecting color pattern, but *Ambystoma* larvae raised in the dark tend to be darker than those raised in light. In a series of *rosaceum* from 6 mi. WSW of Las Adjuntas, Durango, one group of larvae from a spring hole are darker than any others examined. Zweifel (Field notes filed in MVZ) mentions that the hole was covered by boards which apparently cut off light, since there were no algae in the spring. He also states that they were much darker in life than those found in nearby streams.

As metamorphosed animals grow they become darker, the spots being reduced to a faint series along the sides. However, some individuals may have small, faint spots scattered over the body. Fig. 1 is a generalized series representing the ontogenetic color changes.

Habitat

Ambystoma rosaceum apparently breeds in the deeper pools of mountain streams. Most larval specimens in MVZ have come from streams with a gentle gradient, and usually in or near a meadow. The stream at Yaguirachic, Chihuahua, where large larvae were taken in early July, 1957, had many dry portions or flowed slowly underground prior to summer rains. Larvae were found in clear, isolated pools, 6 to 12 inches deep.

There was little or no aquatic vegetation. Large rocks bounded the pools but those on the bottom seldom exceeded 1 foot in diameter. A fine, light colored silt, ½ to 2 inches deep, was present on the bottom, and twigs, needles and cones of *Pinus chihuahuana* littered most of the pools. Water temperatures recorded at sites where larvae were taken ranged between 14.0 and 17.8° C. At mid-day the maximum temperature recorded for shallow portions of the pool was 24.2° C. The stream bed meandered through a small meadow surrounded by pine-madrone forest. *Pinus chihuahuana* dominated the area, madrones (*Arbutus*) being found mainly on slopes. Upon leaving the cienega the stream flowed through a steep canyon, heavily shaded by Douglas fir (*Pseudotsuga*).

Alden H. Miller records *rosaceum* larvae from a similar stream situation near Pacheco, Chihuahua (Field notes filed in MVZ). Near Las Adjuntas, Durango and El Vergel, Chihuahua, they have been taken in situations not unlike that at Yaguirachic (Zweifel, Field notes in MVZ). Zweifel also records *rosaceum* larvae from a spring hole, 4 ft. by 3 ft. by 14 inches deep, near Las Adjuntas, Durango.

When disturbed, larvae in the pools attempt to hide under stones on the bottom. However, they are relatively easy to capture with a net or by hand.

Adults presumably spend the non-breeding seasons under cover or, more likely, underground in the forests surrounding the streams used for breeding. Metamorphosed individuals have been taken under logs and boards around moist meadows, during the breeding season. The series of breeding adults from Neviero was taken by John Davis in a wooden trough which diverted water from a nearby stream to a small village. The salamanders were moving single file toward the stream in the algae-covered trough. An adult female was taken by S. B. Benson in a gopher trap on May 22, 1936 near Colonia Garcia, Chihuahua.

At Yaguirachic, *Bufo microscaphus, Rana pipiens,* and *Hyla eximia* were found along the same stream as *Ambystoma rosaceum.*

Systematics

In his study of geographic variation in *Ambystoma tigrinum,* Dunn (1940) pointed out the pitfalls involved in attempting to utilize larvae, newly metamorphosed individuals, and single specimens in taxonomic work with members of the genus *Ambystoma.* Recent studies have demonstrated the great geographic and altitudinal variation in the life history pattern, and the concommitant effects on structure and color pattern in larvae and metamorphosed individuals of *Ambystoma gracile* and *A. macrodactylum* (Synder, 1956; Farner and Kezer, 1955; Anderson, 1960). These studies and the discovery of metamorphosed adult *A. rosaceum* have prompted me to review the status of Mexican species and subspecies related to *rosaceum* and based on larvae. The larval and metamorphosed *rosaceum* in the MVZ collection provide an essentially complete series of stages, from small larvae through adults, for comparison.

Typical material of *A. r. nigrum, A. r. sonoraensis* and *A. fluvinatum* falls well within the range of variation of large series of *rosaceum* larvae from either Chihuahua or Durango. Shannon's diagnosis of *A. r. nigrum* fits many large and metamorphosing larvae from Chihuahua. The two most important characters listed for *nigrum,* darker ground color and dark ventral bands, are not diagnostic. The darker trunk coloration is characteristic of older larvae throughout the range of *rosaceum.* Larvae from the El Salto region of Durango near the type locality of *nigrum,* do not have ventral bands, whereas these bands appear in large, dark larvae from Chihuahua, though not consistently. The color characters given by Shannon for *A. r. sonoraensis* fail to distinguish it from large larvae elsewhere in the range. Since body proportions, especially relative limb length, change throughout larval development, the limb length character pointed out by Shannon is of little diagnostic value.

Taylor (1941:145) figures the type and a paratype of *Ambystoma fluvinatum* from Mojarachic, Chihuahua, the type locality of *A. rosaceum* described in the same paper. They are darker and somewhat different in color pattern from his illustration of *rosaceum.* However, the paratypes which I examined are indistinguishable from dark larvae of *A. rosaceum.* Moreover, some of the larger series of *rosaceum* larvae in MVZ include individuals similar to the types of *rosaceum* and *fluvinatum,* as figured by Taylor, as well as intermediates. The reduced fins mentioned by Taylor in the diagnosis of *fluvinatum* are of no taxonomic value since the type is obviously in the process of metamorphosis. The tooth characters mentioned are also of little use since the tooth structure and arrangement may change drastically at metamorphosis.

It is my opinion that all of this material represents one species, *Ambystoma rosaceum*, which at present cannot be separated into populations worthy of taxonomic recognition. *Ambystoma rosaceum* regularly transforms throughout the range and future systematic work should be concerned with adult characters. Larval characters may be of use but are unreliable unless one knows the details of the life history in the areas under consideration. We know little enough about the factors affecting the life history pattern and practically nothing about environmental modification of larval structure and coloration. These considerations alone should invalidate names proposed on the basis of larval characters in forms with such variable life histories as *Ambystoma*. As further adult specimens become available it may be possible to demonstrate geographic variation in *A. rosaceum*. If so names are available. It seems unlikely from the nature of the habitat and the amount of collecting already done that there is another species of *Ambystoma* within the range of *rosaceum*. If so it must be restricted in either range or habitat. *Ambystoma rosaceum* might be shown to intergrade, either to the north or east, with *Ambystoma tigrinum* for the two are similar in some respects. However, there is not yet sufficient material available to clarify the relationships of these species.

Fig. 2. Distribution of *Ambystoma rosaceum*. Localities are listed in the text.

Distribution

Ambystoma rosaceum is found at high elevations in the Sierra Madre Occidental from the region of El Salto, Durango, to northern Chihuahua and northeastern Sonora (Fig. 2). The type locality of *A. r. sonoraensis*, given as "32 mi. south of the Arizona border" (Shannon, 1951:468) remains as the only record for Sonora and the northern most station for the species. The locality provided for the type of *sonoraensis* by Doris M. Cochran is Pinetos Camp, Nogales, Mexico (P.L. Jouy, collector). Field work in Sonora is critical since this indefinite locality is not too distant from known localities of *A. tigrinum stebbinsi* (Lowe, 1954) in southern Arizona. One specimen, a large larva is possibly mislabeled; MVZ 24684 reads 200 mi. NE Durango, Durango, which would place it in desert country. However, 200 miles northwest of Cd. Durango, would place it in the Sierra Madre where all other specimens have been taken. The locality would then be in the state of Chihuahua, not Durango.

Locality Records for specimens examined (Fig. 2) *Chihuahua:* Rio Gavilan, 7 mi. SW Pacheco, 5700 ft. (MVZ 46627); 9 mi. SE Colonia Garcia (MVZ 20681); Yaguirachic, 130 mi. W Chihuahua, 8500 ft. (MVZ 65929-42); 7 mi. SW El Vergel (Lagunita), 7800 ft. (MVZ 58631-44); 3 mi. NE Rio Verde (Town), 7600 ft. (MVZ 58645-47); Vicinity of Santa Barbara, 6500 ft. (AMNH 53520-22 + 7; 53526 + 2); Mojarachic (Paratype *A. fluvinatum*, USNM 137205). *Durango:* 6 mi. WSW Las Adjuntas, 8500 ft. (MVZ 58648-92); Rio Hondo, near Las Adjuntas, 8000–9000 ft. (MVZ 57298-316); 2 mi. NE La Cuidad, 8000 ft. (MVZ 58693-96); Neviero, 4 mi. W La Cuidid, 8200 ft. (MVZ 57274-91; Juan Manuel, 200 mi. NE (?) Durango (MVZ 24684); near Otinapa (AMNH 53573); 10 mi. SW El Salto, 10,100 ft. (KU-uncataloged); 9 mi. SW El Salto, 9900 ft. (KU 40495-511); 6 mi. SW El Salto, 10,200 ft. (KU-uncataloged); El Salto (Holotype *A. r. nigrum*—USNM 123581). *Sonora:* Pinetos Camp, Nogales, (Holotype *A. r. sonoraensis* USNM 17253; Paratype USNM 17255).

Summary

Metamorphosed adult *Ambystoma rosaceum* are described. Males have longer tails

and shorter bodies than females. *A. rosaceum* regularly metamorphoses throughout its geographic range and has a life history adjusted to summer rains characteristic of western Mexico. The variation and ontogenetic changes in color pattern have particular reference to their use in the systematics of *rosaceum* and related forms. It is suggested that *A. fluvinatum, A. rosaceum nigrum* and *A. r. sonoraensis* be relegated to the synonymy of *A. rosaceum* since all of the characters utilized to distinguish these forms were based on larvae and fall within the range of population and age variation in large series of *rosaceum* larvae from Chihuahua and Durango.

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A Comparison of the Larvae of Five Northeastern Species of *Ambystoma* (Amphibia, Caudata)

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GOOD descriptions of at least some size classes of larvae of the northeastern species of *Ambystoma* are available, but identification of larvae at all sizes has not been possible. Excellent descriptions of newly hatched and fully grown larvae of *A. jeffersonianum, A. maculatum, A. opacum,* and *A. t. tigrinum* can be found in Bishop (1941), but characters for distinguishing larvae of other sizes are not recorded. Smith (1911) compared small larvae of *A. jeffersonianum, A. maculatum,* and *A. t. tigrinum* from Syracuse, New York. Orton (1942) compared certain features of fully grown *A. texanum* larvae with those of some extralimital species and illustrated a large *A. texanum* larva from Mississippi. Good drawings of newly hatched *A. opacum* larvae from Washington, D. C., appeared in Noble and Brady (1933).

While conducting a distributional study on the salamanders of southeastern Ohio (Seibert and Brandon, 1960), I experienced difficulty identifying many *Ambystoma* larvae, even with the aid of previous works. Since the larvae of *Ambystoma* could be collected more readily and for a longer period of time during the year than could adults, it was necessary to find characters for distinguishing species on the basis of larval specimens of any size. Therefore, eggs of *A. jeffersonianum, A. maculatum, A. texanum,* and small larvae of *A. opacum* were collected and raised to metamorphosis in the laboratory (Brandon, 1958,

M. S. thesis, Ohio University). At a later date, eggs of *A. t. tigrinum* were obtained and the larvae kept for a short time only. At a still later time (spring of 1961) an opportunity was afforded to examine developing larvae of *A. jeffersonianum, A. opacum, A. maculatum,* and *A. t. tigrinum* from Mammoth Cave National Park, Kentucky. Thus, larvae of all species of *Ambystoma* occurring in northeastern United States, except *A. laterale,* were examined as they developed. The status and range of *A. laterale* are still uncertain. It was deemed best to postpone studies on the larvae of *A. laterale* until pending taxonomic studies on this form have been completed. It is at least certain that observations here reported for *A. jeffersonianum* are not based in any part upon its sibling *A. laterale.*

Table 1 is a comparison of certain morphological traits of the five species examined. In addition, pigmentation patterns characteristic of each species are discussed. By reference to Table 1, the discussion, and the figures, it is intended that larvae of any size may be identified. The figures are not intended to be morphologically exact, but are used to show pigmentation patterns.

It should be mentioned that size at hatching varies considerably. In all cases but one, the larvae hatched in the laboratory at a smaller size than is usual in the field. In the case of *A. opacum,* hatching may be postponed for a considerable time if water is withheld (Bishop, 1941, p. 145). If hatching is postponed sufficiently, balancers may be lost before hatching. As shown by Table 1, balancers were lost at about 18 mm. in *A. opacum* whether the larva had left the egg envelopes or not. In all larvae examined the stage of morphological development seemed to be mainly a function of size, not age. Larvae badly retarded in growth by lack of food did continue toe and limb development to some degree. Such stunted individuals do not fit into the table satisfactorily. Size, in turn, depended upon the amount of food eaten. In any one group of larvae hatched out at a given time, quite different rates of development were observed depending upon the amount of food each individual consumed.

Newly hatched larvae were fed small crustacea, mainly copepods and cladocerans. Larger larvae were fed a variety of organisms: newly hatched frog and toad larvae, smaller salamander larvae, small earthworms, and white worms (Oligochaeta, Enchytraeidae). Large larvae, especially *A. jeffersonianum* and *A. t. tigrinum,* were cannibalistic, readily devouring smaller larvae in the same aquarium. Newly hatched frog and toad larvae were excellent food, but of limited use because of the short time during the year when they were available. The most reliable food source for small to medium-sized larvae was the culture of white worms, sold commercially as a tropical fish food. Small earthworms were best for large individuals.

Ambystoma jeffersonianum

Material examined.—Eggs were collected in large numbers near Logan, Hocking Co., Ohio, on 20 Feb. 1957, and later the same season. Small larvae were collected in a roadside ditch in Stroud Run, Athens Co., Ohio, 31 Mar. 1957, as they emerged from egg masses. Emerging larvae were found in a small pond in Mammoth Cave National Park, Edmonson Co., Kentucky, 26 Mar. 1961, and small larvae were taken from the same pond one month later.

Newly hatched larvae.—Larvae 11 mm. long (all measurements are of total length) had a distinctly yellowish ground color, as did newly hatched larvae of *A. t. tigrinum* and *A. texanum,* which gradually became less pronounced as development progressed. Dots of dark pigment were concentrated on the back to form a series of blotches along both sides of the dorsal body fin (see Bishop, 1941, p. 120). The throat and belly were unpigmented, although tiny flecks of black were often present bordering the lower jaw (as in Fig. 2a).

Half grown larvae.—Individuals 27 mm. long still exhibited traces of the dorsal black blotches, although the larger the specimen, the more indistinct the blotches. Light spaces, spots, and flecks were scattered over the dark back as remnants of former light spaces between blotches. A mid-lateral row of separate or partially fused light spots was present extending from gills to base of tail. The margin between the darkly pigmented sides and the unpigmented belly was usually irregular in outline. The head was very large in proportion to body size and, together with the thick, heavily pigmented tail fin, gave the larva a short, stubby appearance. The throat was essentially pigmentless, the jaw bordered by dark pigment.

Metamorphosing individuals.—Bishop (1941) reported metamorphosis to occur in individuals from 48–75 mm. in length. Larvae were observed in this study to metamorphose at about 45 mm. One specimen 46 mm. long with small gill remnants still exhibited

TABLE 1. COMPARISON OF CERTAIN FEATURES OF FIVE SPECIES OF *Ambystoma*

Total Length in mm.	Species	Balancers	Anterior Limbs	Posterior Limbs	Throat Pigment
13	jeffersonianum	+	small limb buds	none	−
	t. tigrinum	−	very small limb buds	none	−
	maculatum	+	2 toe buds	small limb buds	−
	opacum	+	2 toe buds	none	+
	texanum	+	2 toe buds	none	+
14	jeffersonianum	+	limb buds	none	−
	t. tigrinum	−	small limb buds	none	−
	maculatum	+	2 toes	small limb buds	−
	opacum	+	2 toe buds	none	+
	texanum	+	2 toes	none	+
15–16	jeffersonianum	+	2 toe buds	none	−
	t. tigrinum	−	limb buds	none	−
	maculatum	−	3 toes	2 toe buds	−
	opacum	+	2–3 toes	none	+
	texanum	+	2 toes, 1 bud	limb buds	+
17–18	jeffersonianum	−	2 toes, 1 bud	small limb buds	−
	t. tigrinum	−	2 toe buds	none	−
	maculatum	−	3 toes, 1 bud	3 toes	−
	opacum	+	3 toes, 1 bud	small limb bud	+
	texanum	−	3 toes	limb buds	+
19–20	jeffersonianum	−	3 toes	limb buds	−
	t. tigrinum	−	2 toe buds	none	−
	maculatum	−	3 toes, 1 bud	3 toes, 1 bud	−
	opacum	−	4 toes	limb buds	+
	texanum	−	3 toes	2 toe buds	+
22–23	jeffersonianum	−	3 toes, 1 bud	2 toe buds	−
	t. tigrinum	−	2 toes, 1 bud	none	−
	maculatum	−	4 toes	3 toes, 1 bud	−
	opacum	−	4 toes	limb buds	+
	texanum	−	3 toes, 1 bud	2 toes	+
25–26	jeffersonianum	−	3–4 toes	3 toe buds	−
	t. tigrinum	−	2 toes, 1 bud	none	−
	maculatum	−	4 toes	4 toes	−
	opacum	−	4 toes	2 toe buds	+
	texanum	−	4 toes	3 toes	+
28–30	jeffersonianum	−	4 toes	2 toes, 2 buds	−
	t. tigrinum	−	3 toes, 1 bud	3 small toe buds	−
	maculatum	−	4 toes	4 toes, 1 bud	−
	opacum	−	4 toes	3 toe buds	+
	texanum	−	4 toes	4 toes	+
33–35	jeffersonianum	−	4 toes	3 toes, 1 bud	−
	t. tigrinum	−	4 toes	not examined	−
	maculatum	−	4 toes	5 toes	−
	opacum	−	4 toes	3 toes, 1 bud	+
	texanum	−	4 toes	5 toes	+

TABLE 1—*Continued*

Total Length in mm.	Species	Balancers	Anterior Limbs	Posterior Limbs	Throat Pigment
38–40	jeffersonianum	–	4 toes	4 toes	–
	t. tigrinum	–	4 toes	not examined	–
	maculatum	–	4 toes	5 toes	–
	opacum	–	4 toes	4 toes, 1 bud	+
	texanum	–	4 toes	5 toes	+
42–45	jeffersonianum	–	4 toes	5 toes	–
	t. tigrinum	–	4 toes	not examined	–
	maculatum	–	4 toes	5 toes	–
	opacum	–	4 toes	5 toes	+
	texanum	–	4 toes	5 toes	+

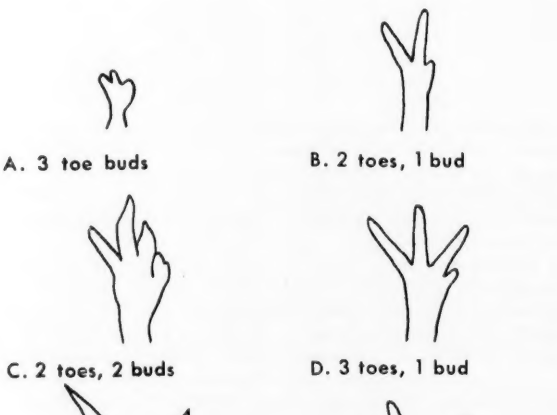

Fig. 1. Sketches showing method used in counting toes and toe buds.

the pigmentless throat and belly. The head, back and sides were uniformly covered with dark pigment. A row of large light spots was evident laterally. Shortly after losing the gills, individuals developed tiny flecks of blue on the back and sides.

Ambystoma maculatum

Material examined.—Eggs were collected by H. C. Seibert in a small pond in Bolster Hollow, near Lake Hope, Vinton Co., Ohio, 22 Mar. 1957. Eggs containing embryos of nearly hatching size were found in Mammoth Cave National Park, 16 Mar. 1961, and small larvae in the same pond one month later.

Newly hatched larvae.—Larvae 14 mm. long had a brownish ground color, and the back was covered with uniformly dispersed dark dots of pigment (see Bishop, 1941, p. 120). There was usually a mid-lateral pigmentless band extending from gills to base of tail. The throat and belly were pigment-

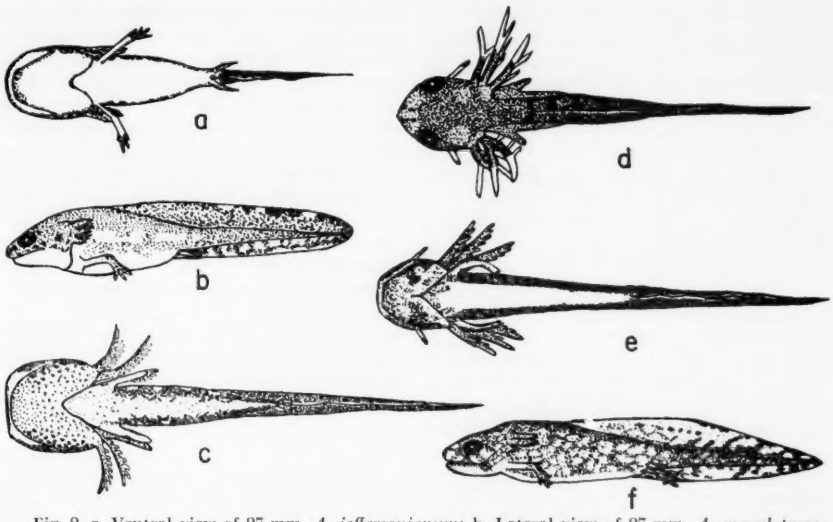

Fig. 2. a. Ventral view of 27-mm. *A. jeffersonianum*; b. Lateral view of 27-mm. *A. maculatum*; c. Ventral view of 17-mm. *A. opacum*; d. Dorsal view of 12-mm. *A. texanum*; e. Ventral view of 12-mm. *A. texanum*; f. Lateral view of 31-mm. *A. texanum*.

less as in *A. jeffersonianum* and *A. t. tigrinum*.

Half grown larvae.—Head, back and sides of 27 mm. larvae were still covered with uniformly dispersed pigment. The head was not much wider than the trunk, and the general appearance was long and slender, not short and stubby as *A. jeffersonianum* and *A. t. tigrinum*. Traces of the lateral light band were still present (Fig. 2b). In general, the overall appearance of these larvae changed little during development.

Metamorphosing individuals.—A 35 mm. larva, just beginning to metamorphose, still exhibited a pigmentless throat and belly, although the margin of the lower jaw was heavily pigmented. Pigmentation on the back and upper sides consisted of a uniform reticulated pattern, which gradually changed to small dots along the lower sides. The dorsal paired spots characteristic of adults appeared almost immediately after metamorphosis was completed, while the general ground color became increasingly darker.

Ambystoma opacum

Material examined.—Larvae 17 mm. long were collected in large numbers 25 Nov. 1957, in a small swampy area near Waterloo Wildlife Area, Athens Co., Ohio. Since Bishop (1941) gave 15–17 mm. as hatching size in New York, the Athens Co. specimens were probably very recently hatched. Larger larvae could be obtained throughout the winter in the same swampy area. Half grown larvae (30 mm.) taken from a pond in Mammoth Cave National Park, 16 Mar. 1961, agreed in all respects with those from Athens Co.

Newly hatched larvae.—Dorsal pigmentation of the 17 mm. Athens Co. specimens consisted of dense, evenly dispersed black stippling. A distinct lateral row of light spots was evident (see Noble and Brady, 1933). The entire throat was evenly pigmented and several to many dots of black were present on the belly (Fig. 2c). Several eggs collected in Churn Creek Reservoir, Shawnee State Forest, Adams Co., Ohio, 18 Oct. 1959, by J. E. Huheey, hatched in the laboratory. These larvae were 12–13 mm. at hatching and showed all the distinctive features of the 17 mm. Athens Co. specimens. Pigmentation was more intense, but balancers, a well pigmented throat, and lateral light spots were all present.

Half grown larvae.—Individuals 32 mm. long were pigmented essentially the same as those at 17 mm., except that the lateral row of light spots was more distinct. In addition, dorsal and ventrolateral rows of smaller light spots had appeared. The throat was still uniformly pigmented over most of its surface.

Metamorphosing individuals.—Larvae beginning metamorphosis (37–50 mm.) were

pigmented dorsally much like *A. maculatum*. From a dorsal view it was nearly impossible to tell which species was at hand. However, the throat and belly of metamorphosing *A. opacum* were well pigmented, and remains of the lateral and ventrolateral light spots were visible. Immediately after loss of gills, tiny white flecks appeared on the back and sides. At first the flecks were uniformly scattered, later becoming concentrated into bands characteristic of adults.

Ambystoma texanum

Material examined.—Eggs were collected near Frankfort, Franklin Co., Kentucky, 8 April 1958, by H. C. Seibert. Also about 8 April 1958, eggs and adults were found in a small stream in French Park, Hamilton Co., Ohio. On 22 April 1961, larvae just breaking out of the egg envelopes were collected in a stream in Mason Co., Kentucky. The contrast between this type of egg laying situation (streams) and that used by other northeastern *Ambystoma,* as well as by *texanum* itself in other areas (ponds, ditches, swampy fields, etc.), is striking. *A. jeffersonianum, maculatum, t. tigrinum,* as well as *texanum* in more western parts of its range, lay few to many eggs in masses, all the eggs of one mass being held together by a surrounding matrix. These egg masses are then attached to floating or submerged vegetation. However, eggs of *A. texanum* found in Franklin and Mason counties, Kentucky, and Hamilton Co., Ohio, were attached individually to the undersides of rocks in streams, like those of *Eurycea bislineata*. Although attached separately, they were side by side in loose groups. Larger larvae of *texanum* were seen swimming in a rapidly flowing stream in Madeira, Hamilton Co., Ohio, 13 June 1960.

Newly hatched larvae.—Larvae 12 mm. long were heavily pigmented, appearing superficially darker than larvae of the other species. Pigment along the dorsal body fin was arranged into a series of about six faint to distinct transverse bands (Fig. 2d). The sides were heavily pigmented ventral to a level just below attachment of the limbs. Ventrolateral pigment outlined a distinct, straight-margined, pale mid-ventral band extending from fore limbs to the vent. The throat was heavily but unevenly pigmented (Fig. 2e).

Half grown larvae.—Larvae 31 mm. long were pigmented dorsally like those newly hatched, but the transverse bands were less distinct. The sides were pigmented unevenly, suggesting a reticulated network of black (Fig. 2f). The mid-ventral pale band was still present, but contained a few dots of black. The throat was still pigmented, although more sparsely, the pigment being concentrated along the posterior margin of the jaw.

Metamorphosing individuals.—Specimens beginning to metamorphose (37–41 mm.) possessed the well pigmented throat and a distinct light band ventrally. The dorsal pigmentation differed little from that of *A. opacum* and *A. maculatum* except that it was less uniform, appearing slightly mottled. The adult coloration developed as a gradual darkening of the dorsal pigment. Two specimens, 37 mm. and 40 mm., had completely lost the gills and tail fin and had begun to darken.

Ambystoma t. tigrinum

Material examined.—Eggs of this species, collected about 25 Mar. 1959, near San Jose, Tazewell Co., Illinois, by K. L. Williams, and others collected near Mason City, Mason Co., Illinois, by R. Altig, hatched in the laboratory and the larvae were raised. Newly hatched larvae were collected in Mammoth Cave National Park 16 Mar. 1961, and larger specimens later the same summer. Larger specimens (40–60 mm.) from Illinois in the University of Illinois Museum of Natural History were also examined.

Newly hatched larvae.—Viewed from above these resembled *A. jeffersonianum* in possessing paired dorsal dark blotches (see Bishop, 1941, p. 166). They also had a pigmentless throat and proportionally large head. Where *A. jeffersonianum* possessed a lateral series of light spots, the pigment between the spots was missing in *A. t. tigrinum*, resulting in a light band extending from gills onto the lower half of the tail. Other authors have pointed out the distinctive absence of balancers in newly hatched larvae of this species.

Half grown larvae.—These specimens, in most cases, showed a well developed lateral light band, and the throat and belly were still without pigment. A few specimens exhibited lateral light spots as in *jeffersonianum*, and were almost impossible to distinguish from that species by pigment alone. In these cases the shape of the toes (broad and pointed in *t. tigrinum*, slender and rounded at the tip in *jeffersonianum*) (see Fig. 1e and 1f) served to distinguish them. Only faint traces of the dorsal blotches remained, and the intensity of pigmentation was less than in newly hatched.

Metamorphosing individuals.—No larva of *t. tigrinum* was raised to metamorphosis in the laboratory. Since this species transforms at a much larger size than any other species treated here (90–123 mm.) (Bishop, 1941), their recognition should present no problem. Large numbers of transforming larvae were observed in Mammoth Cave National Park 5 July 1961. Specimens 105–111 mm. long possessed only remnants of gills. Dorsal coloration consisted of dark scattered spots and flecks over a moderately dark ground color. The throat and belly were covered with uniformly dispersed dark flecks and dots. Specimens 83–97 mm. long possessed larval coloration and showed no signs of gill reduction.

Acknowledgments.—This study was begun as part of a Master's thesis in the Department of Zoology, Ohio University, and has been continued at the University of Illinois. The many suggestions and criticisms by H. C. Seibert during the initial phases are most sincerely appreciated. H. M. Smith, P. W. Smith, and J. E. Huheey have read the manuscript and offered many helpful suggestions. Financial support for field trips from the Department of Zoology, University of Illinois is acknowledged with gratitude.

SUMMARY

Larvae of *Ambystoma jeffersonianum, A. maculatum, A. opacum,* and *A. texanum* from Ohio and Kentucky, and of *A. t. tigrinum* from Illinois and Kentucky differ slightly in all stages (Table 1). The principal differences involve the size at which limbs and toes develop, presence and persistence of balancers, pigmentation, and size at metamorphosis. *Ambystoma texanum* differs from the other species in manner of egg deposition and larval habitat.

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Generic Reallocation of *Tropidodipsas leucomelas* Werner

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WERNER (1916) described *Tropidodipsas leucomelas* on the basis of a specimen from Cañon de Tolima, Colombia, collected by Fassl in 1910. Peters (1960) pointed out that no characters of generic importance were included in the original description. He doubted the relationship of this species with *Tropidodipsas,* a genus otherwise unknown south of Honduras. In the features described by Werner, *leucomelas* does not differ from many dipsadine species, and Peters therefore tentatively referred it to the genus *Dipsas.* A male specimen recently obtained by the Museum of Zoology, University of Michigan (UMMZ 121040: Colombia: Cauca: Moscopan, *ca.* 3050 meters above sea level; Marte Latham, 1957) reveals that *leucomelas* differs considerably from both *Tropidodipsas* and *Dipsas.* The relationships of the species are with the genera *Tripanurgos* Fitzinger and *Siphlophis* Fitzinger.

DESCRIPTION OF MOSCOPAN SPECIMEN

Head wide, distinct from neck; rostral twice as broad as high; internasals and prefrontals broader than long; prefrontals not entering orbits; frontal as long as width of its anterior margin, five-sided; median suture of parietals shorter than length of frontal; nasal single; nostril about equidistant from anterior and posterior margins of nasal, reaches dorsal margin; slight depression in nasal just posterior to nostril; loreal small, longer than high, separated from orbit by single, high preocular; supraoculars 1–1, forming long suture with frontal; postoculars 2–2; anterior temporals 2–2; posterior temporals 3–3; lower anterior temporal only

narrowly separating upper anterior temporal from supralabial 6; supralabials 8–8, 4 and 5 in orbit, order in decreasing length along lip 8–7–6–5–4–1–3–2; infralabials 8–8, 1 through 4 in contact with anterior chin shields, fifth narrowly in contact with anterior and broadly in contact with posterior chin shields; first pair of infralabials in broad contact medially, separating mental from chin shields and extending posteriorly between anterior chin shields to form major part of distinct mental groove; anterior chin shields slightly longer than posterior; eye large, prominent, barely visible from below; pupil vertically elliptical; vertical diameter of eye about twice its distance from lip. (Fig. 1).

Body and tail elongate, strongly compressed; dorsal scale rows 17–17–15, reduction occurring above ventral 126 on left and ventral 124 on right by loss of scale row 4; scales smooth, bearing paired apical pits (pits absent from lowermost scale row); width of vertebral scale row enlarged at mid-body to about 1.5 times width of paravertebral scales, less enlarged anteriorly and posteriorly; ventrals 201; anal plate entire; subcaudals in 92 pairs. Total length in mm., 572; tail length, 159 (27.8 percent).

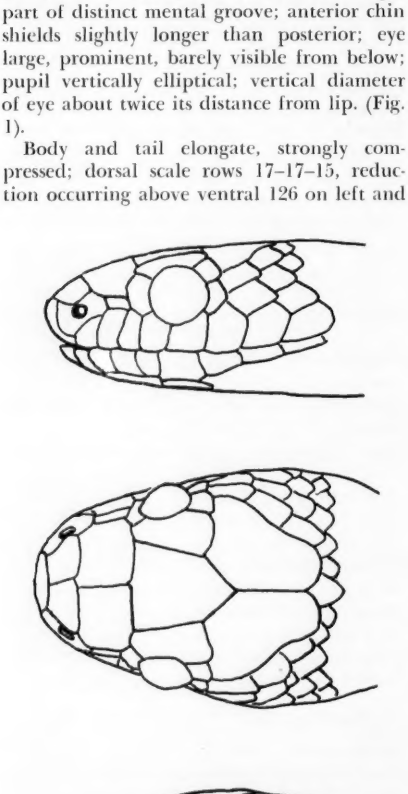

Fig. 1. The head scales of *Tripanurgos leucomelas* (Werner). UMMZ 121040.

Maxilla extending anteriorly to middle of supralabial 1; 8 (sockets for 5 more) maxillary teeth, longest anteriorly, followed by diastema and 2 enlarged teeth, distinctly grooved on anterior surface; about 14 mandibular teeth, decreasing in size posteriorly.

Hemipenis bilobed, extending to level of subcaudal 8; *m. retractor penis magnus* inserting on vertebra above subcaudal 23, extending anteriorly to divide at subcaudal 10, one slip attaching to each hemipenial lobe; *sulcus spermaticus* bifurcates at subcaudal 3, one branch extending to apex of each lobe; hemipenis differentiated into three major areas: (1) short basal area extending to subcaudal 2, bearing a few small spines on otherwise smooth surface; basal part longitudinally ridged; (2) central part of organ extending from subcaudals 3 through 5, and covered with large spines; sulcus bifurcating in proximal part of central area; (3) distal segment, comprised of two lobes, bearing papillate calyces; basic ornamentation modified on each lobe by three longitudinal ridges; central ridge non-calyculate, bearing one large spine proximally, several smaller spines centrally, and large, soft papillae distally, separated from ridges lateral and medial to it by naked furrows; lateral and medial ridges calyculate; calyces of proximal part of ridges bearing small spines, those of distal part bearing papillae; lateral and medial ridges join at apex of lobe, forming elevated disk at tip.

Color pattern of alternating dark and light rings; dark rings (in alcohol) brownish-black; light rings cream; dark rings on body, 30; on tail, 17; all dark rings complete across venter, but rings, and therefore ventral connections, somewhat oblique rather than perpendicular to longitudinal axis of body; some light rings incomplete dorsally, resulting in middorsal connection of dark rings 3 through 6, 8 through 11, and 16 and 17; dark rings consistently wider than light rings. Rostral, internasals, nasals, prefrontals, preoculars, supraoculars, postoculars, frontal, supralabials 1 through 4, infralabials 1 through 3, and mental brownish-black; light band encircling posterior part of head, occupying most of

parietals, first 3 rows of neck scales, temporals, supralabials 7 and 8, infralabials 6 through 8, and first 3 ventrals; demarcation between dark and light areas not sharply defined, giving mottled appearance to anterior parts of parietals, supralabials 5 and 6, infralabials 4 and 5, chin shields, and gular region.

Variation

To my knowledge, four specimens of *Tropidodipsas leucomelas* have been collected. The location of the type is unknown, but it is not in the Vienna museum (NHMW) as supposed by Peters (1960:97). The Vienna collection, however, does contain two topotypes (NHMW 16509.1 and 16509.2), collected by Fassl, the collector of the type. According to Dr. J. Eiselt (pers. com.) of the Vienna museum, the two topotypes were labeled as such by Werner himself. Charles F. Walker has been kind enough to compare the present specimen with the topotypes, and data presented for the latter are taken from his notes.

The topotypes and the Moscopan specimen (UMMZ 121040) conform closely to Werner's original description. The four have in common 1 preocular, 2 postoculars, 2 anterior and 3 posterior temporals, smooth scales, and a pattern of dark rings which tend to encircle the body obliquely. Some variation occurs in the number of supralabials. The type and UMMZ 121040 have 8 supralabials on each side, but NHMW 16509.1 has 7–7, and NHMW 16509.2, 8–7. Where 8 supralabials are present, 4 and 5 border the orbit; where 7 are present, 3 and 4 border the orbit. In the two topotypes the first supralabial and the loreal are in contact; in UMMZ 121040 these scales are separated by the nasal and supralabial 2, which are in contact. The upper anterior temporal in the Moscopan specimen is narrowly separated from the supralabial series by the lower anterior temporal and the lower postocular; this separation is greater in the topotypes.

Among the characters not mentioned in the original description are scale reduction, dentition, body shape, presence or absence of apical pits, number of infralabials, and imperfect dorsal separation of the dark rings. The scale rows of the type are given simply as 17, but the topotypes agree with UMMZ 121040 in that there is a reduction to 15 posteriorly by the loss of scale row 4. The maxillary of NHMW 16509.1, examined *in situ*, bears 10 teeth (gaps for 3 or 4 more) followed by a diastema and two enlarged, grooved teeth. The topotypes also agree with the Moscopan specimen in having strongly compressed bodies and 8 infralabials. Dr. Eiselt was kind enough to send me several scales from each of the topotypes. These scales apparently lack apical pits. As in the Moscopan specimen, some of the light rings are incomplete middorsally in NHMW 16509.1, resulting in dark rings 1 through 12, and 16 through 18 being connected dorsally. The dark rings are as wide or wider than the light rings in all four specimens.

Table 1. Variation in Four Specimens of *Tripanurgos leucomelas* (Werner)

	Type	UMMZ 121040	NHMW 16509.1	NHMW 16509.2
Ventrals	206	201	186	194
Subcaudals	80	92	93	90
Dark body rings	33	30	33	26
Dark tail rings	15	17	21	15
Total length in mm.	240	572	224	181
Tail length in mm.	54	159	56	47.5
Percentage tail of total	22.5	27.8	25.0	26.2

Variation in the number of ventrals and subcaudals, and in the number of body and tail rings, is presented in Table 1.

Generic Allocation

The species *leucomelas* differs from those of *Tropidodipsas* in having opisthoglyphous dentition, paired apical scale pits, a reduction in the dorsal scale rows posteriorly, and an enlarged vertebral scale row. It also differs from *Dipsas*, in which Peters (*op. cit.*) tentatively placed it, in the opisthoglyphous dentition, paired apical pits, distinct mental groove, and two pairs of well-developed chin shields. The features which characterize *leucomelas*, with minor exceptions, fit two neotropical, monotypic genera, *Tripanurgos* Fitzinger and *Siphlophis* Fitzinger.

The two species of these genera, *Tripanurgos compressus* and *Siphlophis cervinus*, have many characteristics in common. I have examined seven specimens of *T. compressus*: UMMZ 60784 (2), 63211, 67920, 91553-4, 121062; and four specimens of *S. cervinus*: UMMZ 60707, 63210, 67901 (2). Both are similar to *leucomelas* in having elongate, compressed bodies, opisthoglyphous dentition, enlarged anterior maxillary and man-

dibular teeth, smooth scales bearing paired apical pits (possibly a variable character), dorsal scale row reduction, and a bilobed hemipenis with a bifurcate *sulcus spermaticus*. Peters (1958) gave the dorsal scale formula of a specimen of *S. c. cervinus* from Ecuador as 21–19–17, but the four I have examined agree with *Tripanurgos compressus* in having 19–17–15, the reductions resulting from the loss of the fourth scale row. The scales of the head are similar in *Tripanurgos* and *Siphlophis,* although differences occur in the orbital region. The number of maxillary teeth, excluding the enlarged fang-like teeth, may be somewhat higher in *Siphlophis* (14–17) than in *Tripanurgos* (13–15). Color pattern in the two species consists of dark cross-bars on a light ground color, but the bars in *S. cervinus* are irregular and extend across the ventral surface, while those in *T. compressus* are well-defined and limited to the dorsal surface. The head scales of *S. cervinus* are dark, with lighter edges. The head scales are white in five of the seven specimens of *T. compressus*. The anterior head scales are dark, however, in two Ecuadorian specimens (UMMZ 91553–4, 828 and 442 mm. in total length, respectively); thus Bailey's statement (1940: 69) that the head is white except in large adults needs qualification. The ranges of ventrals and subcaudals for seven specimens of *Tripanurgos* are 219–242, mean 236, and 108–119, mean 113; for four specimens of *Siphlophis* 224–228, mean 226, and 91–105, mean 97.

The major characteristics distinguishing these obviously closely related genera are the mandibular dentition and the size of the vertebral scale row. In *Siphlophis* mandibular teeth 3 through 5 are strikingly larger than the teeth preceding and following them (Bailey, 1940:34); in *Tripanurgos* the mandibular teeth gradually decrease in size posteriorly. The scales of the vertebral and paravertebral rows are subequal in *Siphlophis*; in *Tripanurgos* the vertebral row is strongly enlarged, a character variable within *Imantodes* (Peters, 1953, 1954) and dipsadine genera (Peters, 1960). Both *T. compressus* and *S. cervinus* have one preocular, 2 postoculars, and 8 supralabials, but the arrangement of these scales differs in the two species. In *compressus* the orbit is bordered anteriorly by the high preocular, ventrally by supralabials 4 and 5, and posteriorly by the two postoculars. In *cervinus* the preocular is shorter, allowing supralabial 3 as well as 4 and 5 to border the orbit. In two specimens, UMMZ 63210 and 67901B, supralabials 3 through 6 border the orbit. In these two specimens supralabial 6 extends between the lower postocular and supralabial 5 to touch the orbit. The lower posterior part of the loreal in *Siphlophis* extends toward the orbit between the preocular and supralabial 3. This loreal extension tapers to a point and is narrowly separated from the orbit by the preocular and supralabial 3. In *Tripanurgos* the loreal has no posterior extension and is widely separated from the orbit by the preocular and supralabial 3.

The species *leucomelas* shares many characteristics with *Siphlophis* and *Tripanurgos*. It differs from known species of both in having a dorsal scale formula of 17–17–15 (instead of 19–17–15). It is closer to *Siphlophis* in the lower ventral and subcaudal counts, and in the extension of the dark bands onto the ventral surface. In the characters presently used to distinguish *Siphlophis* from *Tripanurgos,* however, *leucomelas* agrees with *Tripanurgos*: the mandibular teeth gradually decrease in size posteriorly, the scales of the vertebral row are enlarged, supralabials 4 and 5 enter the orbit, and there is no loreal extension between the preocular and supralabial 3. This species should, therefore, be known as *Tripanurgos leucomelas* (Werner), new combination.

Summary

Peters (1960) doubted the relationship of *Tropidodipsas leucomelas* Werner with other species of *Tropidodipsas,* and tentatively placed *leucomelas* in the genus *Dipsas*. Examination of a newly acquired specimen and of two topotypes in the Vienna museum reveals that *leucomelas* differs from *Tropidodipsas* in having opisthoglyphous dentition, a posterior reduction in the number of dorsal scale rows, an enlarged vertebral scale row, and paired apical pits. It differs from *Dipsas* in the opisthoglyphous dentition, paired apical pits, distinct mental groove, and two pairs of well-developed chin shields.

The features of *leucomelas* indicate relationship with the closely related genera *Tripanurgos* and *Siphlophis*. In *Tripanurgos* the mandibular teeth gradually decrease in size posteriorly, the vertebral scale row is enlarged, supralabials 4 and 5 border the orbit, and there is no loreal extension between the preocular and supralabial 3. In

Siphlophis mandibular teeth 3 through 5 are strikingly larger than the teeth anterior and posterior to them, the vertebral scale row is not enlarged, supralabials 3 through 5 border the orbit, and there is a loreal extension between the preocular and supralabial 3. The species *leucomelas* shares many characteristics with both *Tripanurgos* and *Siphlophis,* but in the features distinguishing the two *leucomelas* agrees with the former and is therefore allocated to the genus *Tripanurgos.*

Acknowledgments.—I wish to thank Norman Hartweg for permission to study specimens under his care, and Thomas M. Uzzell, Jr. for certain useful suggestions. I am particularly indebted to Charles F. Walker for comparing the Moscopan specimen with the topotypes in the Vienna museum, and for the notes he made available. I thank these three, Frederick R. Gehlbach, and James A. Peters for helpful criticisms of the manuscript, and Josef Eiselt for sending me dorsal scales taken from the topotypes.

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Three New Lizards of the Genus *Liolaemus* from the Highest Andes of Chile and Argentina

R. Donoso-Barros

THIS paper is based on the study of a lizard collection made by the author in the Antofagasta Cordillera (1958) and of some specimens obtained by Rodolfo Ruibal (University of California, Riverside) in the Mendoza Cordillera during his stay in Argentina last summer (1960–1961). We are very grateful for Dr. Ruibal's collaboration. Study of these reptiles enabled us to recognize three new species belonging to the genus *Liolaemus.* The Antofagasta collection included lizards recorded from Peru and Bolivia, among them *Liolaemus pantherinus, L. pulcher, L. mocquardi, L. bolivianus, L. walkeri, L. variabilis,* and *L. multiformis.*

Liolaemus paulinae nov. sp.

Holotype.—Male 536, Lab. Biol. from Calama on the Loa River, Antofagasta, Chile. 2600 m. altitude, 14-II-1958.

Paratypes.—5 males; 2 females; 2 juveniles; all from the type locality.

Diagnosis.—This species is characterized by the small size, the shorter hind limbs, the uniform pale-brown color above, and the absence of a dorsal pattern (Fig. 1C).

Description of holotype.—General form slender. The adpressed hind limb reaches the shoulder. Tail one and half times as long as head and body. Cheeks prominent. Upper head scales rather large, smooth. Rostral transversely expanded. One azygous frontal separated from the interparietal by a pair of frontoparietals. Interparietal smaller than parietals. A series of four small supraoculars (three or four in the paratypes). Subocular expanded; a single series of scales between labials and subocular. Five supralabials and infralabials. Temporal scales gently keeled; ear opening great and quadrangular. Sides of the neck granular, slightly plicate, with a short longitudinal fold. No antehumeral fold. Dorsal scales of moderate size, more or less rhomboidal, keeled, not mucronate. The keels form longitudinal lines. The caudal scales are triangular at the beginning of the

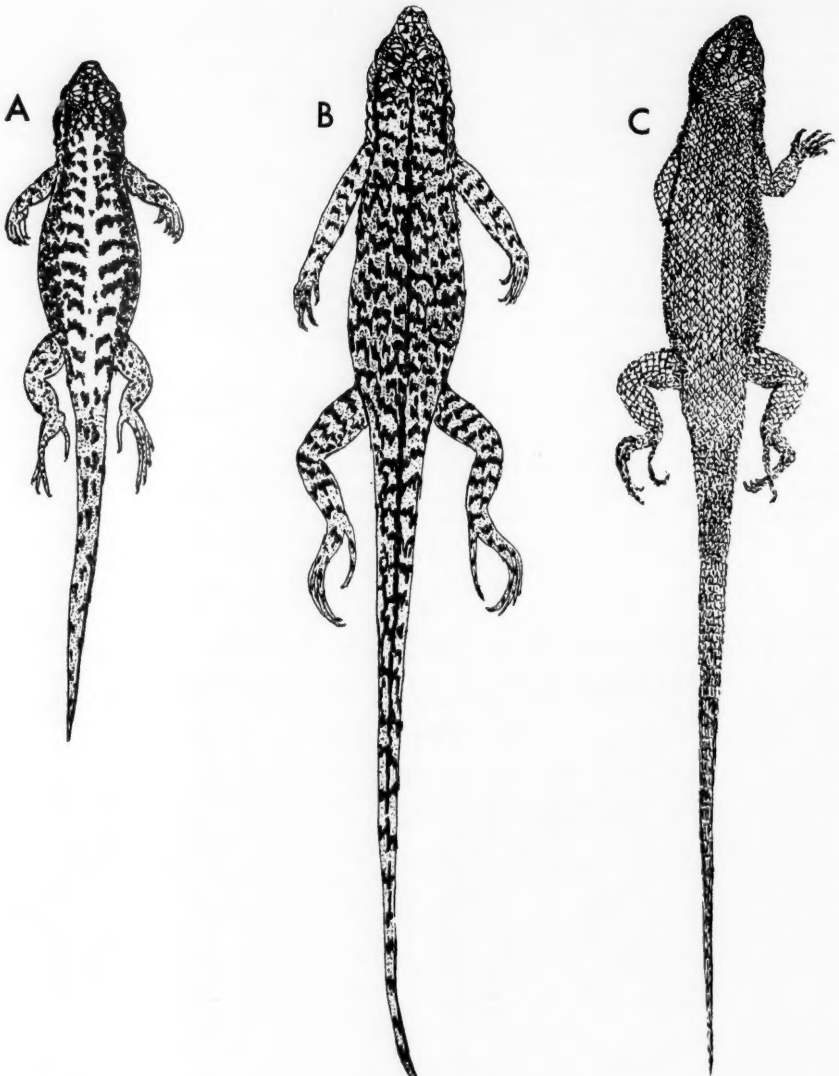

Fig. 1. New species of lizards from Chile and Argentina: A. *Liolaemus ruibali*, B. *Liolaemus constanzae*, C. *Liolaemus paulinae*.

tail, squarish with diagonal keels in the middle, and lanceolate at the end. Limbs scales keeled. Ventral scales rounded, imbricate, smooth, larger than dorsals. 52 scales around the middle of body. Three anal pores.

Pale brown above, without pattern. The upper part greyish white, with reddish tints in the living animal.

Measurements are given in Table 1. This series is very homogeneous, only the youngest

examples show two pale bands on the side of the back that recall *Liolaemus gravenhorsti*. This species is insectivorous and lives in the shrubs on the margin of the Loa River. The stomach contents were composed of small coleoptera and flies.

Comparisons.—Closely allied with *Liolaemus gravenhorsti* and *cyanogaster, L. paulinae* differs from these lizards in the small size and the absence of dorsal bands. Other swifts from the Andes of Peru and Bolivia related to *paulinae* are *L. alticolor* and *L. walkeri*; from these two species it differs in the absence of dorsal pattern and vertebral line.

Liolaemus constanzae nov. sp.

Holotype.—Male 553, Lab. Biol., from Peine, Antofagasta, Chile. In chañares forest. 3000 m. altitude. 16-II-1958.

Paratypes.—5 males, 13 females, 3 juveniles; localities in Table 2.

Diagnosis.—A medium-sized lizard with a

TABLE 1. MEASUREMENTS (mm.) OF TYPE SERIES OF *Liolaemus paulinae*

Identification			Head plus body	Head length	Head width	Head height	Tail	Fore limb	Hind limb	Foot
No.	Sex	Age								
510	♀	young	33.5	10	8.5	6	57	15.5	24	13.7
511	♀	adult	40	12	9	8	77	19.5	31	16.5
513		young	35	10	8	5	57.5	12	20.5	11
536	♂	adult	52.5	14	11	8	75	20.5	31	16
538	♂	adult	52	12.5	10	7	80	19	32.5	18
539		young	35	10	8.7	6	70	13	23.5	13
541	♂	adult	46	12	9.5	6.5	55	14.5	28	14.5
534	♂	adult	50	13	11	8.5	—	20	23	16
535	♂	adult	48.2	12	11	8	82	17	31	16.5
536	♂	adult	52.5	14	11	8	75	20.5	31	16

TABLE 2. MEASUREMENTS (mm.) OF TYPE SERIES OF *Liolaemus constanzae*

Identification			Head plus body	Head length	Head width	Head height	Tail	Fore limb	Hind limb	Foot	Locality
No.	Sex	Age									
556	♂	adult	58	15	12	9	103	23.4	40.5	21	Peine
543	♂	adult	55	14	10	7.5	63	22	34	19	Quitor
544	♂	adult	61.5	15	11	9	70	22	37	19	Quitor
553	♂	adult	60	15	12.5	9.5	104	23.5	41.5	22	Peine
557	♂	adult	61	14	11	9	—	22	34.5	16	Peine
565	♀	adult	54	14	11	8.5	104	24	37	19	San Pedro
503	♀	adult	57	13.5	10.8	7.6	67	21	32	18	Estacion S. Pedro
507	♀	adult	57	13.5	10.5	7.8	68	22	34	17	Estacion S. Pedro
542	♀	adult	58	14	11.8	9	—	20.5	36.5	19	Quitor
545	♀	adult	55	13	11	7.5	47	20	32	17	Quitor
546	♀	adult	43	10.5	9.5	6.5	57.5	10	27	16	Quitor
547	♀	adult	53.2	13	11	8	96	19.2	32.5	20	Quitor
548	♀	adult	52	13	10	7.5	91	19	31	18.5	Quitor
551	♀	adult	51	12.5	11	7.5	—	21	32	18	Peine
554	♀	adult	52	11	10	9	80	20	32	15	Quitor
555	♀	young	46	10	9	6.5	—	18	28	15	Quitor
558	♀	adult	53	13	10.5	7	65	22.5	32	18	Puritama
559	♀	young	41	11	10	7	—	19	27	17	Puritama
560	♀	young	43	12	8	6.5	—	20	30	15	Puritama
549		young	38	9.5	9	4	66	17	22	13.8	Quitor
550		young	39	11	9	6	—	16	31	15	Quitor
562		young	39	10	7	5.5	50	16	25.5	13	Puritama

black vertebral line and the back crossed by broken black bars. Between these bars multicolored dots (Fig. 1B).

Description of holotype.—Medium size. Head slender. Ear opening triangular with three prominent scales on the anterior border. The adpressed hind limb reaches the shoulder. Tail one and half times as long as head and body. Neck with a longitudinal fold between ear and shoulder. Upper head scales smooth. One azygous frontal, smaller than prefrontals. Rostral rounded, transversally expanded. Interparietal triangular and very small, about a half the size of the parietals. Three supraoculars. A single series of scales between subocular and infralabials. Five infralabials and six supralabials.

Dorsal scales rounded, moderately keeled. The posterior back scales enlarged. Ventral scales rounded, smooth, of the same size as dorsals. Scales of the sides of the neck very small but only a few are granular. Forelimb scales without keels. Hind limb scales gently keeled. Hind sides of thighs granular. Caudal scales squarish, diagonally keeled, the terminal scales very thin and mucronate. Scales around the middle of body 67. Three yellowish anal pores.

The living animal after exposure to the sun presents a multicolored aspect over a pale brownish olive color. A black vertebral line between the posterior part of the pileus and the proximal third of the tail. A short pale band between the postocular and auditory region. Back crossed by broken black bars; among them many white, blue, and green dots. Head scales mottled with black and white points.

Ventral region greyish white. Belly reddish with black dots transversally disposed. Mental region marbled with black.

When the warmth of the sun decreases, the animal acquires a darker brown tone mottled with black. This chromatophoric response recalls the color changes of other Chilean *Liolaemus*, such as *L. tenuis* and *L. monticola* (Skoknic, 1956).

Female.—General form and scales similar to the male. Two azygous frontals. Four supraoculars. Scales of the anterior border of ear not prominent. Ventral scales as large as dorsals. Four supralabials and infralabials. Above brown greyish with transverse bars of blackish spots. Vertebral line interrupted. Multicolored mottling less abundant than in the male.

Variation.—The scales are gently keeled in some specimens. One animal has 5 supraoculars. In rare examples we found two azygous frontals. The most important variations are restricted to the dorsal pattern. The transverse bars in a few animals are weakly differentiated. The young animals are characterized by lines of dots distributed on each side of the back. The vertebral line is represented in all the lizards examined, though it is occasionally feebly marked and interrupted.

This nice swift is distributed around San Pedro de Atacama Valley, Salar de Atacama, hills in the vicinity of San Pedro, and the vicinity of little villages like Peine.

The stomach contents include little spiders, chitinous formations of coleoptera, flies' wings, little seeds of a grass, and some plant residues.

Comparisons.—The general form recalls *Liolaemus pulcher*. From this form *constanzae* differs in the number of scales around the body, the absence of a patch of enlarged scales in the posterior side of thighs, and the dorsal pattern. The other species that recalls the washed-out aspect of some specimens fixed in alcohol is *L. pantherinus*, but the dorsal pattern of *constanzae* is never formed by four longitudinal series of quadrangular spots as in *pantherinus*.

Liolaemus ruibali nov. sp.

Holotype.—Male 621, Lab. Biologia, from "entre Villavicencio y Uspallata," Mendoza, Argentina. 3000 m. altitude. 17-II-1961. Rodolfo Ruibal legit.

Paratype.—One male and one female from the same locality.

Diagnosis.—A small species characterized by the short head with prominent supraocular regions. Limbs very short. A high number of scales around the middle of body (87) and the dorsal pattern formed by short transverse stripes on each of the back sides. Vertebral region without pattern (Fig. 1A).

Description.—This lizard is characterized by the small size. Head neck, and snout very short. Supraocular region very prominent. Limbs short. Tail as long as head and body. Adpressed hind limb reaches axilla. Cheek very convex. Rostral hexagonal and convex. Nostril opening laterally. Two azygous frontals. Five supraoculars transversely dilated. Interparietal about half size of parietals. Suboculars divided. A single series of scales between subocular and supralabials. Six supralabials and 5 infralabials. Three prominent scales on anterior border of ear; the median scale larger than the others. Sides of the neck gently plicate, a short antehumeral fold. Dorsal scales very small, rounded, imbricate,

TABLE 3. MEASUREMENTS (mm.) OF TYPE SERIES OF *Liolaemus ruibali*

Identification			Head plus body	Head length	Head width	Head height	Tail	Fore limb	Hind limb	Foot
No.	Sex	Age								
621	♂	adult	55	13	12	9	67	19	30	15
622	♂	adult	55	13	12	9.2	47.5	18	26	13.7
623	♀	adult	51	11.5	10.2	8	70	19	26.2	14

without keels. Flank scales as large as dorsals. Tail scales enlarged with keels oriented medially; only a few scales diagonally keeled. Limb scales similar to dorsals. Ventral scales rounded, flattened, smooth, and imbricate. Scales around middle of body 89. Six anal pores.

Pale brown-olive above. A short white band lined with black between eye and ear. The upper black line of this band reaches the antehumeral fold. Short transverse stripes on each side of back. The posterior borders of these bars are pale. The vertebral region is without patterns. The flanks have irregular blackish spots lined by turquoise points. The black spots alternate with orange spots. Ventral region greyish white with yellow tints. The belly is darkly mottled.

Measurements are given in Table 3.

Female.—General features and scales similar to the male. Ventral region greyish white, without pattern.

The stomach contents were composed of some Coleoptera and Diptera. The three specimens were found under stones.

Comparisons.—Allied with *L. monticola monticola* from the Chilean Andes, *L. ruibali* differs from it in the large number of scales, the absence of a black patch on the flank, and the shorter hind limbs. Another close species is *Liolaemus darwini* from which *ruibali* differs in the dorsal pattern and in the absence of a shoulder patch.

Another species from the highest Andes of Mendoza, related to *darwini* by Boulenger (1899), is *Liolaemus fitzgeraldi*, but this species is very different by comparison. Another form, very poorly known, *L. microphalis*, has no distinct head scales and the dorsal scales are strongly keeled (Werner, 1909). Neither of these features exists in *L. ruibali*.

SUMMARY

Three new swifts, *Liolaemus paulinae, L. constanzae,* and *L. ruibali,* have been discovered in the high Andes of Chile and Argentina. *Liolaemus paulinae* lives in the shrubs on the margin of the Loa River and *L. constanzae* in the San Pedro de Atacama Valley. *Liolaemus ruibali* was found under stones in the Andes of Mendoza, Argentina. *Liolaemus paulinae* and *L. ruibali* are insectivorous, whereas *L. constanzae* ingests some plant material as well as insects.

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The Herpetofauna of Tishomingo County, Mississippi, with Comments on its Zoogeographic Affinities

DENZEL E. FERGUSON

TISHOMINGO County, in northeastern Mississippi, shares common boundaries with the states of Alabama and Tennessee and is situated on the periphery of the Cumberland Plateau (Fig. 1). From a herpetological standpoint, this area has been the least known section of the state. The present account is based on 333 specimens collected in the vicinity of Tishomingo State Park by the writer and his students on five visits be-

Fig. 1. The geographic location of Tishomingo Co., Mississippi showing major landmarks.

tween 1957–1961 and is not intended to represent a complete list of species.

The county, classified as Tombigbee and Tennessee River Hills (Stephenson and Monroe, 1940), is divided by north-south ridges in such a manner that it is drained by three different rivers: Hatchie, Tombigbee and Tennessee. The general topography varies from smoothly rounded hills separated by broad valleys, to hills and ridges of 200 feet relief having steep slopes, narrow crests and narrow valleys. Red or gray sands and clays of upper Cretaceous age are predominant with limited Paleozoic sandstone, shale and limestone outcrops exposed along larger streams. The soils of the county are generally of poor quality, perhaps explaining evidence of attempts to diversify industry, for caches of both homebrew and moonshine whiskey were revealed in the course of collecting.

Bear Creek, the major Mississippi tributary of the Tennessee River, originates in Alabama, flows northward through Tishomingo Park and crosses back into Alabama before emptying into Pickwick Lake. The stream occupies a gorge walled by sandstone cliffs, in places reaching over 200 feet above the valley floor. Although the highest point in Mississippi is in the county (806 ft.), most collecting was concentrated between 460–590 feet elevation (Morse and Brown, 1936). The park area abounds with springs, seeps and small boulder-strewn streams, which, along with the sandstone outcrops and talus, provide excellent habitat for amphibians and reptiles.

The vegetation of Tishomingo County is generally oak-hickory forest with hydrophytic species (e.g. bald cypress, *Taxodium distichum*) and relics (e.g. chestnut oak, *Quercus montana*) from the upland eastern region occurring in protected ravines and bottoms. More xerophytic mixed forests or nearly pure stands of pine or second growth oak grow on drier exposures.

Unless otherwise noted, all specimens in the following list are from Tishomingo Park. An asterisk (*) denotes a new state record.

An Annotated List of Amphibians and Reptiles Collected in Tishomingo County

Cryptobranchus alleganiensis alleganiensis Daudin*.—Nine hellbenders were obtained from Bear Creek with hooks baited with crayfish or minnows (*Notropis, Notemigonus*), the minnow baits proving more productive. All specimens were caught at night along with several channel catfish (*Ictalurus punctatus*), three freshwater drums (*Aplodinotus grunniens*) and a flathead catfish (*Pylodictis olivaris*).

Ambystoma opacum Gravenhorst.—Two specimens.

Desmognathus fuscus fuscus Rafinesque.—All specimens show extreme variation in coloration and pattern but seem best assigned to the subspecies *fuscus*. Large numbers of dusky salamanders were obtained in seeps, springs and small streams.

Plethodon dorsalis dorsalis Cope.—Whereas Brode (1957) reported the species under sandstone slabs, the present 33 specimens were found either at the bases of cliffs under moist moss or in moist leaf litter.

Plethodon glutinosus glutinosus Green.—Very common.

Pseudotriton porphyriticus porphyriticus Green*.—The night of April 21, 1961 a large specimen was found resting on a mat of moss by a spring at the base of an over-hanging cliff. A dusky salamander was present in the spring, several green salamanders were noted in nearby crevices, and numerous camel crickets clung to the cliff surface. A second specimen was later captured on a moist woodland road but escaped.

Pseudotriton ruber ruber Sonnini*.—Seven

specimens, mainly from Tishomingo Park. Additional collecting will be required to determine where *ruber* intergrades with *vioscai* of the coastal plain.

Aneides aeneus Cope and Packard*.—Green salamanders were exceedingly common in cracks and fissures in sandstone cliffs along Bear Creek, 39 specimens being obtained. An occasional individual was found clinging to the cliff surfaces, fully exposed; however, its green and black color pattern rendered it perfectly camouflaged against the lichen covered sandstone.

Eurycea bislineata bislineata Green X *E. b. cirrigera* Green.—The seven specimens at hand have interrupted lateral stripes on the tail and less pigment on the lateral tail surfaces as in *bislineata*; two males possess the cirri of *cirrigera*.

Eurycea longicauda longicauda Green X *E. l. guttolineata* Holbrook.—In a series of 13 *E. longicauda*, three typify *guttolineata* and three *longicauda*. The remaining seven have intermediate color patterns showing a perfect graduated transition between the two extremes. The occurrence of *E. l. longicauda* in Tishomingo County constitutes a new addition to the known Mississippi herpetofauna and extends the known range slightly.

Bufo terrestris americanus Holbrook.—On April 22, 1960, a number of ponds were visited 1–3 miles south of the town of Tishomingo along Highway 25. Nearly every pond supported mixed choruses of *Bufo woodhousei fowleri*, *Hyla versicolor*, *Hyla crucifer*, *Acris gryllus* and *Rana clamitans*. At three ponds *B. t. americanus* were heard calling with *fowleri* and, although no actual count was conducted, it seemed a reasonable estimation that several hundred *fowleri* were present for each *americanus* heard. The *americanus* were all brick-red in color, matching the soil color of the area, and either lacked dorsal spots or had very tiny ones. The American toad has not been reported south of this locality in northeastern Mississippi.

Bufo woodhousei fowleri Hinckley.—Very common.

Acris gryllus gryllus Le Conte.—Cricket frogs were abundant near permanent ponds.

Hyla crucifer crucifer Wied.—Spring peepers were common in mixed choruses of hylids.

Hyla avivoca avivoca Viosca.—Several were collected from calling perches 4–5 feet up in trees and shrubs bordering a pond. *Rana catesbeiana*, *Rana clamitans* and a single *Hyla crucifer* were also heard calling at the time. The range of the bird-voiced tree frog apparently attains its northeastern limit somewhere in the vicinity of this location.

Hyla versicolor versicolor Le Conte.—Gray tree frogs were heard and collected at a number of places.

Pseudacris brachyphona Cope*.—Mountain chorus frogs were heard in several localities but only collected successfully from a shallow road-side ditch located 0.5 miles west of Tishomingo Park headquarters. Males were heard and collected here on all April trips.

Rana catesbeiana Shaw.—Although only two individuals were retained, numerous others were heard and captured. Three large bullfrogs obtained for the frying pan were each found to contain a breeding adult *fowleri*.

Rana clamitans melonota Rafinesque.—Green frogs from Tishomingo County are difficult to assign to subspecies and probably represent intergrades with the bronze race of the coastal plain.

Rana pipiens sphenocephala Cope.—Four specimens.

Chelydra serpentina serpentina Linnaeus.—A single specimen.

Sternothaerus odoratus Latreille.—A nest of five eggs was found near Eastport on Pickwick Lake.

Terrapene carolina carolina Linnaeus.—Specimens were obtained from 3.8 miles south of Iuka and in the park.

Anolis carolinensis carolinensis Voigt.—Three were taken and numerous others were seen.

Sceloporus undulatus hyacinthinus Green.—Eight specimens from the park and near Eastport.

Cnemidophorus sexlineatus Linnaeus.—Six-lined racerunners were observed but not captured.

Lygosoma laterale Say.—Ground skinks were the most commonly encountered reptiles.

Eumeces laticeps Schneider.—A single specimen was collected.

Eumeces inexpectatus Taylor.—Although eight *inexpectatus* were acquired in the county, it is of some interest that no *E. fasciatus* were taken. The latter are very common in central Mississippi, whereas *inexpectatus* is rare there.

Eumeces anthracinus pluvialis Cope.—The scutellation of three specimens is that of *pluvialis* while the pigmentation of the dorsal stripe is variable. One individual shows the faint black mid-dorsal lines of the sub-

species *anthracinus*. Until additional collections are made, the population might best be considered as intergrades. These are the first to be reported in the northern half of Mississippi, the nearest records being those of west-central Alabama and south Mississippi. The only other coal skink in the Mississippi State University Collection is from Brookhaven, Lincoln County, Miss.

Natrix sipedon sipedon Linnaeus X *N. s. pleuralis* Cope.—Five specimens from Pickwick Lake (near Eastport) and two from the park exhibit intergradation, with the resemblance to *sipedon* being somewhat more pronounced.

Thamnophis sirtalis sirtalis Linnaeus.—A specimen each from the park and Eastport.

Haldea valeriae Baird and Girard.—A single specimen collected by Wilfred T. Neill and the author; presently in Mr. Neill's possession.

Diadophis punctatus stictogenys Cope.—The 14 ring-necked snakes from the county differ from other Mississippi *stictogenys* in having fewer and smaller spots on the belly, this being more pronounced in the young, most of which have but a single row of small dots along the ventral mid-line.

Carphophis amoenus amoenus Say X *C. a. helenae* Kennicott.—In a series of 10 worm snakes, six have the separate prefrontals and internasals of the race *amoenus*, three have the prefrontals fused with corresponding internasals as in *helenae*, and a single individual exhibits an intermediate condition having these elements partially fused. In 11 *Carphophis* examined from other Mississippi localities, all have these scales fused. Thus, the distribution of the subspecies *amoenus* extends farther west than generally indicated (Conant, 1958) and should be added to the list of snakes known to occur in Mississippi.

Coluber constrictor constrictor Linnaeus.—The hemipenes of a single male lack the enlarged basal spines characteristic of the race *priapus*. Since only *priapus* occurs south of Tishomingo County, the two races must intergrade along the Tennessee-Tombigbee divide. The present specimen is the only Mississippi *C. c. constrictor* known to the author.

Opheodrys aestivus Linnaeus.—A single specimen.

Elaphe guttata guttata Linnaeus.—One corn snake was obtained near park headquarters.

Elaphe obsoleta obsoleta Say X *E. o. spiloides* Duméril, Bibron, and Duméril.—A single subadult specimen (633 mm., total length) is the darkest Mississippi specimen I have examined. All body blotches are solid black, and the same solid black pigmentation nearly obscures the ground color of all dorsal and lateral scales, as contrasted to a diffusion or complete absence of pigmentation in other Mississippi *spiloides* examined.

Cemophora coccinea Blumenbach.—One specimen.

Tantilla coronata coronata Baird and Girard.—Six were taken from under sandstone slabs.

Ancistrodon contortrix Linnaeus.—The only copperhead observed escaped down a burrow. Two specimens from 13 miles southwest of the park (7 mi. SE. Marietta, Prentiss Co., Miss.) resemble the subspecies *contortrix* which probably intergrades with *mokeson* along the Tennessee River.

Sistrurus miliarius streckeri Gloyd.—A living, but injured, individual was found in the road near the main park entrance.

Table 1. Major Distributional Patterns of Species of Amphibians and Reptiles from Tishomingo County, Mississippi

Group	Salamanders	Frogs	Turtles	Lizards	Snakes	Total
Tennessee River Drainage only	4	1	—	—	—	5
Tombigbee River Drainage only	—	2	—	2	2	6
Races which intergrade on the Tennessee-Tombigbee Divide	4	1	1	1	6	13
Widely distributed, unaffected by the Tennessee-Tombigbee Divide	2	6	2	4	5	19
Total	10	10	3	7	13	43

Zoogeographic Considerations

Certain species (four salamanders and one frog) in Tishomingo County have zoogeographic affinities with the Appalachian herpetofauna (Table 1). Their ranges extend into the state from the Cumberland Plateau region of Alabama and Tennessee but are

confined to that portion of Mississippi drained by the Tennessee River (Fig. 1). Another group of six species is widely distributed on the coastal plain and ranges northward to the Tennessee drainage but fails to cross it or barely does so. A third group of species, consisting mainly of salamanders and snakes, is represented by northern and southern races which intergrade along the Tennessee-Tombigbee divide, the zone of intergradation being characterized by its narrowness. The remaining species are more widely distributed and seemingly are not influenced by the presence of the barrier separating the two drainages.

Table 1 appears to corroborate Dowling's (1956) contention that reptiles and frogs, being more motile and having broader ecological requirements, are of less value than salamanders in indicating past distributional patterns. Only two of 10 salamanders exhibit a widespread distribution unaffected by the Tennessee-Tombigbee barrier. The table, also, clearly indicates that the Tombigbee-Tennessee divide (hence coastal plain vs. Cumberland Plateau) has been and remains an effective barrier to distribution and gene flow, its historic role in salamander and snake subspeciation being quite apparent. This fact is rather astounding considering that the present magnitude of the divide is almost negligible, the two drainages in places being separated by only a few feet elevation. The barrier apparently is not entirely a physical one but more likely of an ecological nature, for the habitats associated with rocky outcrops, steep slopes and well aerated, cool, spring-fed streams so common in the Tennessee drainage, are generally lacking on the Tombigbee side, although the distance by which they are separated is a relatively short one.

Restriction of *Cryptobranchus* to the Tennessee drainage is not surprising, for differences in fish faunae between the two river systems also indicate isolation. For example, only a single banded sculpin (*Cottus carolinae*) has been reported from Mississippi, that being one apparently from the Tennessee drainage which has subsequently been lost (Cook, 1959). In the course of the present study a second specimen was procured from Saddle-Back Creek, a Bear Creek tributary in Tishomingo Park.

Certain of the species now confined to the Tennessee drainage of Mississippi have most assuredly once enjoyed a more extensive westward distribution as is indicated by the assemblage of related plethodontid salamanders present in the Ozark and Ouachita area of Arkansas, Missouri and Oklahoma. Dowling (op. cit.) believes that *Eurycea longicauda* and *Plethodon cinereus* (*dorsalis* here) invaded the Ozark-Ouachita region during the pre-Wisconsin pluvial period of the Pleistocene. The recently discovered *Plethodon dorsalis* population in Winston County in central Mississippi (Ferguson and Rhodes, 1958) probably represents a relic population established at the time of that invasion and now disjunct from the main portion of the range. Other such species should be sought in the more hilly sections of central Mississippi.

Summary

Forty-three species of amphibians and reptiles from Tishomingo County, Mississippi include *Cryptobranchus alleganiensis, Pseudotriton porphyriticus, Aneides aeneus* and *Pseudacris brachyphona* which are reported in the state for the first time. An additional four races are added to the known state list and several cases of intergradation between northern and southern races are confirmed. The species collected exhibit four rather distinct distributional patterns: 5 are confined to the Tennessee River drainage, 6 to the Tombigbee drainage, 13 have northern and southern races intergrading along the Tennessee-Tombigbee divide and 19 are widely distributed and apparently unaffected by the presence of the divide. Salamanders are more restricted to a single drainage than are anurans or reptiles. The barrier separating the two drainages is believed to be primarily ecological rather than a purely physical one.

Acknowledgments.—This study was supported in part by a grant made available by the Mississippi Academy of Science. I wish also to express appreciation for the assistance of the several members of my Lower Vertebrate course, without whose aid most of the specimens discussed would still be roaming about Tishomingo County.

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Patterns of Social Behavior in the Desert Iguana, *Dipsosaurus dorsalis*

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THE BEHAVIOR patterns of closely related groups of animals often show both similarities, consistent throughout the group, and differences. The differences may exist in some ritualistic pattern, such as display. It is probable that such differences are the result of environmental selection evolved along with morphological and physiological speciation. A study of behavior differences may reveal the direction of such changes and offer information to aid in establishing relationships between genera and species within the group.

The lizards of the family Iguanidae perform display movements and posturing which are ritualistic in character. Their rituals are a part of the social behavior patterns of aggression, spacing, reproduction and social status. The following study is a part of a program investigating the comparative behavior of the iguanid lizards, with special emphasis on ritualistic patterns. This study is part of a program supported by a grant from the National Science Foundation. I wish to recognize the assistance given me by Mr. Harold Cleveland.

MATERIALS AND METHODS

The desert iguanas used in this study were captured in early April in southwestern Arizona and southeastern California and kept in large cages until early June, at which time they were transferred to a large outdoor enclosure at the University of Oklahoma Biological Station in south-central Oklahoma. This square enclosure (open above) measured 15 feet on a side and contained from six inches to three feet of fine sand arranged into two dunes. A few cinderblocks and small logs were scattered over the enclosure to provide shade. A large clay dish provided a water source. The contents of sweep nettings and large bunches of local wild flowers were provided daily as a source of food. Other lizards in this enclosure included three species of fringed-toed lizards, *Uma notata, U. scoparia* and *U. inornata.*

Temperatures of the sand surface in the enclosure frequently exceeded 120° F. during midday and greatly curtailed lizard activity. Observation periods were primarily from 8:00 a.m. to 11:00 a.m. and 4:00 p.m. to 6:00 p.m., for 20 days between June 10 and August 15, 1960. All lizards were toe-clipped and color marked for easy distant individual recognition. Observations were recorded as longhand notes, tape-recordings, and 16 mm. movie film.

The desert iguanas apparently adjusted quickly to the enclosure for they foraged and fed readily, dug burrows and sunned, paying little attention to the observer sitting under a shade canopy at one side of the enclosure. Undoubtedly the amount and intensity of social interaction was increased because of the space limitations of the enclosure. However, this result was desired.

Fourteen desert iguanas (9 males, 5 females) were placed in the enclosure on June 10. One male and two females died before the termination of the study on August 15.

DISPLAY BEHAVIOR

Though these lizards had displayed in large cages, the frequency of this activity increased markedly when they were transferred to the enclosure. The display pattern varied in intensity; the challenge display was of high intensity, the assertion display of low intensity.

The challenge display of the desert iguana has been analyzed using the eight categories

of Carpenter (1961): site, position, posture, movement type, parts moved, units of movement, sequence and cadence.

The sites from which the desert iguana displayed varied from stations on low flat areas with a poor view to preferred raised stations on top of the dune or on the cinderblocks with wide views of the surroundings.

The position or orientation of the longitudinal axis of a displaying lizard was parallel to the intended recipient or adversary.

The posture assumed during challenge display tended to increase the apparent size of the lizard when viewed laterally. The trunk was compressed, giving the appearance of a slightly arched back and ventrally protruding thorax and abdomen. The dewlap was extended from the throat of the lowered head at the start of the display (Fig. 1). The all-over appearance was that of a crouch. The legs were slightly extended holding the lizard away from the ground. The tail was usually extended. The dorsal roach observed by Norris (1953) was not apparent.

From this position the lizard raised and lowered the head and trunk, most of the movement occurring in the head and shoulder region because of the rapid extension and flexion of the front legs. The body shape did not change during these bobbing movements and the dewlap remained extended.

The movements followed a distinct pattern (Fig. 2). During the first part or unit of the display sequence, the lizard rose to full height on the fully extended front legs, quickly returned to a low crouch by flexing the front legs (the dewlap and thorax sometimes appeared to touch the ground), then immediately rose to full height again, followed by partial flexion of the front legs bringing the head and shoulder region down to about half the full height.

After a short pause, the second unit started from this half-height position: the lizard rose to full height, immediately went into the low crouch, then up to full height, down to half-height and immediately back to full height, and finally down to half-height followed by a slight pause. Thus the second unit differed from the first in having a double shallow push-up following the first single deep push-up. Succeeding units were all the same as the second.

The number of units per display sequence varied from two (units one and two only) to as many as ten, but was usually three or four.

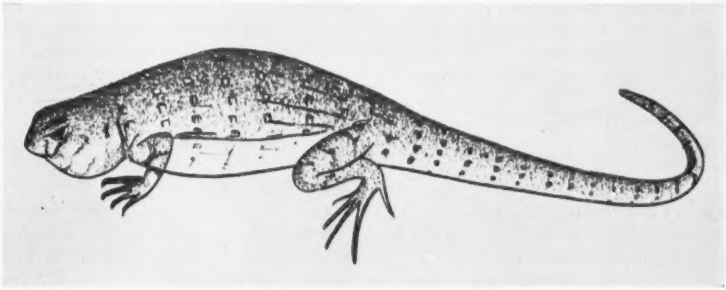

Fig. 1. Display posture of male desert iguana.

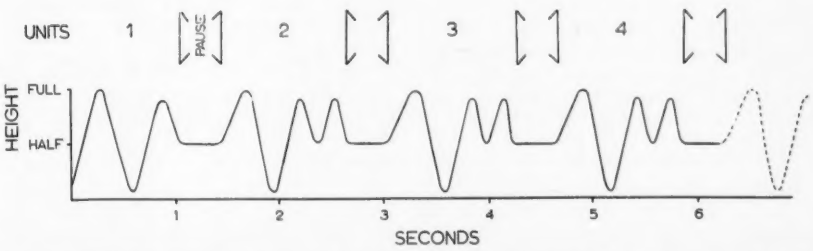

Fig. 2. Sequence and cadence of units of movement in the display of the desert iguana. The graph line represents the movement pattern of the head and shoulder region. For further explanation see text.

An active and aggressive male might repeat a sequence after an interval of only fifteen to twenty seconds.

The durations of the units and sequences were determined from over 200 stop watch timings, by two individuals, using the methods of Carpenter and Grubitz (1961), and were also checked by analyzing 16 mm. movies. The time relationship, called the cadence, is depicted in the graph (Fig. 2). The average time for the first unit was 1.0 second (range 0.7–1.2), for the succeeding units, 1.2 seconds (range 0.9–1.5). The intervals between units averaged 0.4 of a second (range 0.3–0.6).

The assertion display differed from the challenge display in that the height of the push-up movements was not as great and the posture (dewlap extension, lateral compression of trunk, and arching of back) was much less exaggerated, or the posture was similar to that of an alert lizard. However, the sequence and cadence were the same, except that fewer units were performed in succession. There was no specific orientation during assertion display. The assertion display was performed by male and female adults, juveniles and hatchlings. It appeared to function as a territorial declaration, for a lizard moving to a new position frequently displayed on stopping, thus asserting or declaring position.

The challenge display was generally associated with very aggressive actions between two males. Females were rarely observed in challenge display, and then they performed with less exaggeration. Aggressive encounters usually started when two lizards approached each other. When within about two feet or less, one stopped and challenged, the other usually quickly returning the challenge. During such exchanges, the two opponents frequently shifted about over the sand to different sites where they would stop and again challenge.

This display of the desert iguana is distinct from all other genera of iguanid lizards in the United States (as observed by this investigator) and I believe is species-specific, probably functioning for species recognition as indicated by Hunsaker (1960) for the *Sceloporus torquatus* group of lizards.

Dominance

Soon after the desert iguanas were placed in the enclosure, the activities of certain individuals indicated that dominance relationships were being established. Such activities consisted of displays, fights, chases, retreats and submissive posture responses.

Each lizard moved about the enclosure freely at first. When two individuals encountered one another (such encounters varied from awareness at a distance of up to approximately three feet to close approaches of less than one inch) the results varied from passive (non-aggressive) actions to immediate and violent aggressive interactions. One lizard upon seeing another might immediately run quickly away for about a foot or two as if to avoid the other's presence. This retreating lizard (subordinate) was often persistently pursued.

Data on encounters (Table 1) indicated that one individual very quickly assumed the dominant role in the group. This lizard was involved in the majority of the active encounters and was responsible for most of the aggressive activity.

In the group studied, the Or. Sp. male quickly became the dominant. He was the only lizard observed in challenge display during his reign, and he did most of the chasing and also the courting of females (Fig. 3).

On July 1 (after a week's lapse of observations), the Or. Sp. male had incurred an injury to the right front leg which affected his ability to move. Though he still performed weak push-ups, his movements were greatly curtailed. It was apparent on this day that the Or. Sp. male was no longer dominant. The activity of most of the other members of the group had increased markedly as indicated by push-ups, displays, and chases (Fig. 3). The lizard which now won all of his encounters and was most aggressively active was the Wh. Sp. male (Fig. 3). From this time until August 15 when the observations ended, the Wh. Sp. male remained dominant. Though interactions occurred between other members of the group, none successfully challenged the Wh. Sp. male. The Wh. Sp. male was by far the most active of the group, did most of the displaying, chasing and courting. Though the Or. Sp. male appeared later to regain his health, he did not successfully challenge the Wh. Sp. male.

The Or. Sp. male, which was the first dominant, ranked approximately equal in size and weight to two other males, while the only larger male was the Wh. Sp. male which became dominant (he outweighed the others by 10 grams and was 5 mm. longer in body length). I believe it is significant that the largest individual became the dominant, and it is probable that the injury incurred by the Or. Sp. male was inflicted by the larger Wh. Sp. male.

TABLE 1. SOCIAL STATUS CHART FOR AN ENCLOSED GROUP OF DESERT IGUANAS

Results of encounters between June 17 and August 16, 1960. The italic numbers represent that number of encounters occurring after July 1 (injury of Or. Sp. male). The Gr. male was dead on June 27 and the Bu. female on July 15.

	Dominant (Winner)								Total Subordinate Encounters	Total All Encounters	Body length/ Total length (cm.)	Weight (gms.)
	♂					♀						
	Or. Sp.	Yel.	Bu.	Wh. Sp.	Wh.	Blk.	Bu.	Wh.				
Subordinate (Loser)												
♂												
Or. Sp.				*2*				*1*	3	29	13.5/37.2	57.5
Yel.	2			*12*					14	18	13.5/16.8	57.0
Bu.	3			*5*					8	9	13.2/37.2	58.9
Wh. Sp.	2								2	36	14.0/31.2	68.1
Wh.	5	*1*		*2*					8	9	11.5/30.9	51.6
Blk.	3	1		*3*		1			8	8	12.8/23.1	52.8
Or.				*7*		1		*1*	9	9	12.8/23.7	45.5
Gr.	3								3	3	11.3/33.2	43.6
♀												
Blk.	3		*1*	*2*			*1*		7	14	11.7/23.8	54.8
Bu.	1	2(*1*)							3	4	11.2/22.8	36.9
Wh.	4			*1*	*1*	5(*4*)			11	13	13.5/36.0	54.8
Or.											13.2/33.0	52.9
Total Dominant Encounters	26	4	1	34	1	7	1	2	76			

The dominant lizard's presence was often enough to cause another to flee. If the subordinate did not flee, the dominant either performed an assertion display, or a challenge display followed quickly by an aggressive attack and chase. Either display usually drove off the subordinate. Physical contact was rare during pursuit. Some chases covered distances of fifteen to twenty-five feet and were often repeated after short pauses. A pursued lizard tried desperately to escape. The confines of the enclosure undoubtedly affected this and intensified these encounters. The fleeing lizard usually attempted to enter a burrow or hide beneath or behind some object in the enclosure.

The subordinate lizard which was doggedly pursued usually assumed a submissive posture when stopping, either in the open or when hiding beneath an object. A lizard in submissive posture lay flat on the sand, head down, eyes usually closed and the legs extended slightly to the side. A dominant was not aggressive towards a lizard in such a posture. However, if the subordinate moved from this posture while the dominant was nearby, he was immediately attacked and pursued again. The submissive posture was twice observed held for as long as five minutes, though a minute or less was most usual.

When the dominant male was aggressively displaying, other desert iguanas watched intently at distances up to ten feet, and appeared to retreat from displays seen at this distance.

TAIL SLAPPING AGGRESSION

Perhaps an important interaction in determining dominance was the very aggressive encounter involving the vigorous use of the tail.

When two desert iguanas, after responding to each other with challenge displays, aligned themselves facing opposite directions, heads approximately opposite opponents' shoulders, at a distance of three to five inches (Fig. 4b), the following type of aggressive action was observed. One individual (aggressor) assumed a challenge posture about three to four inches anterior and lateral to the less aggressive individual (opponent). The aggressor commenced by moving the tail away

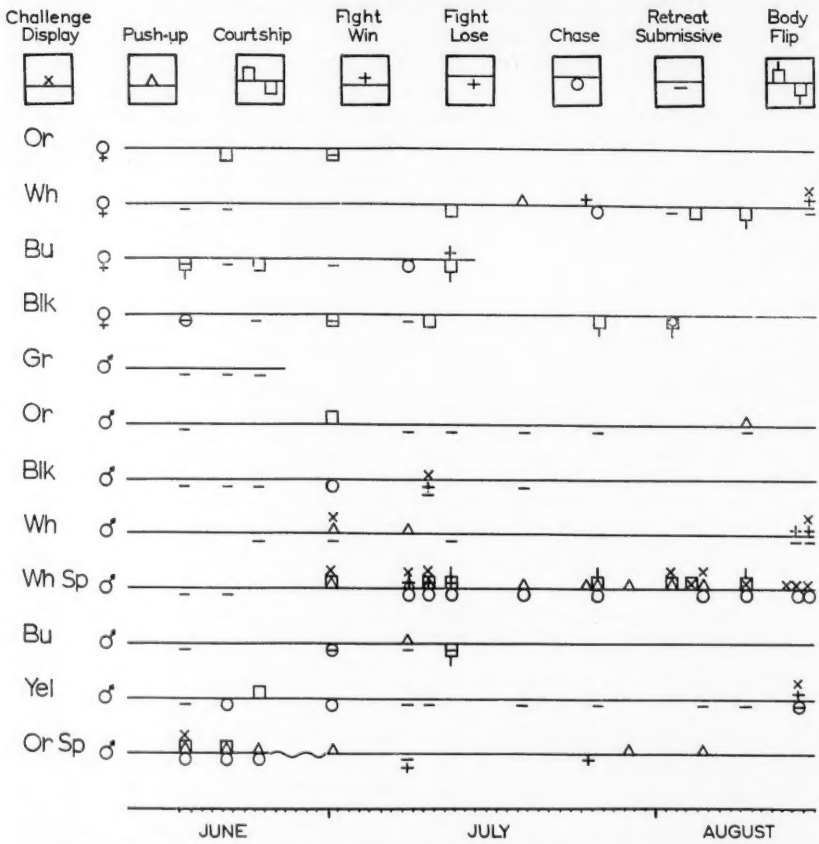

Fig. 3. Social activity chart for an enclosed group of adult desert iguanas, June 17 to August 16, 1960. Frequency of type of behavior on a particular day is not indicated. A discontinued base line indicates individual died or was absent from the enclosure. The wavy base line for the Or. Sp. male indicates the period during which he incurred an injury. The courtship symbol above the line indicates male courtship activity and that below the line indicates the female being courted. The body-flip symbol above the line indicates superior partner and below the line the inverted partner.

from the opponent (Fig. 4c and d), and then reversing the direction of the tail movement, towards the opponent. This motion was accelerated by a vigorous push of the hind leg. At the start of the tail movement, this hind leg of the aggressor (right hind leg when slap was to the left) was flexed, then immediately fully extended (could be seen kicking up sand), which in effect threw the pelvis towards the opponent and increased the force of the now swinging tail (Fig. 4d). As the pelvis began to move in towards the opponent, the forepart of the body and the head moved or leaned slightly away from the opponent (Fig. 4e). As the swinging tail and moving pelvis were approaching the opponent (Fig. 4e and f) the aggressor very rapidly flexed his trunk laterally on the side towards the opponent, which brought the anterior portion of the trunk and the head quickly in towards the swinging tail (Fig. 4f). The whipping tail slapped against one side of the head and body of the opponent as the aggressor's head met the other side, in effect pinioning the opponent (Fig. 4g). Frequently the aggressor's tail met the opponent with a slap heard by the observer at twenty feet. Immediately the aggressor recovered from this

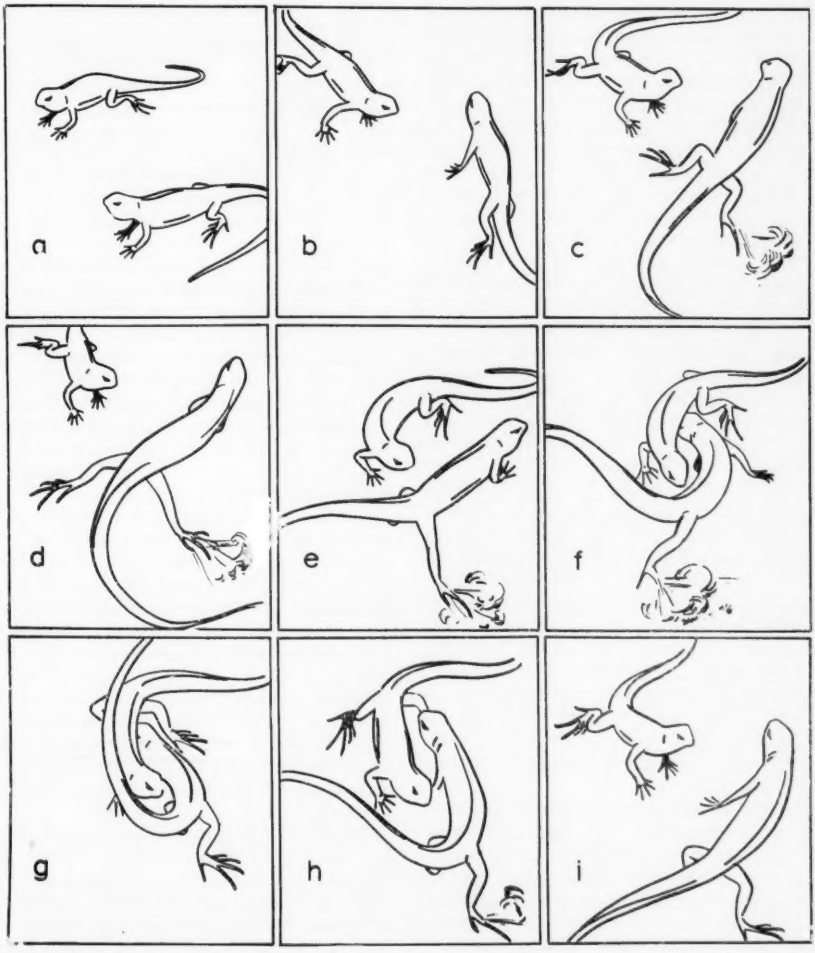

Fig. 4. Sketches taken from slow motion movie showing sequence of movements during aggressive tail slapping behavior of the desert iguana. See text for explanation.

flexion (Fig. 4 h), straightening the tail and extending the trunk back to the original position (Fig. 4 i). The quick return to the starting position places the aggressor in a less vulnerable posture as well as in position for a repeat performance. During some of these performances the opponent appeared to counter the slap by moving its body against the incoming body of the aggressor (Fig. 4 e and f). Sometimes the incoming tail missed the opponent and lashed harmlessly over the opponent's head. Two individuals were observed to slap each other at approximately the same time.

These actions took place very rapidly and appeared as a blur of motion. Timings from a 16 mm. movie, taken at 32 frames per second, indicated a time of 0.5 to 0.7 of a second from the beginning of a slap to the recovery position.

During some tail slapping encounters, the two combatants stood side by side with their head and shoulders pressed against one another, heads opposite opponents' shoulder. Such a position has previously been described (including photo) by Norris (1953). In this position they jostled for position by leaning and pushing against each other as if tryng to

make the other give ground. They were observed to change direction and still hold this pose. The tails remained relatively inactive and extended during this jostling. Jostling lasted from only a few seconds up to a minute or longer. During such jostling, the more aggressive lizard was observed to perform weak push-up movements. They usually broke from this position when the more aggressive lizard suddenly jerked away and immediately commenced tail slapping again.

This jostling position may be a defense posture, for while in this position the lizards would find it more difficult to perform effectively the tail slapping movements.

The tail slapping encounters were not of regular occurrence during aggressive displays and there was no discernible way to predict their occurrence. Such encounters lasted from a few seconds, with two to three tail slaps, to as long as three to five minutes with repeated tail slapping, vigorous displaying, retreat, pursuit, jostling and pauses in activity. One individual was usually more aggressive than the other and accounted for the great majority of the tail slapping. The more aggressive individual was the victor (in all observed encounters) as the other lizard retreated.

Both sexes were involved in tail slapping interactions. On July 8, the Wh. Sp. male challenged the Or. Sp. male, which did not retreat; the Wh. Sp. male then moved into a challenge position and started tail slapping. After being slapped about five times, the Or. Sp. male retreated. On July 12, the Bu. female challenged the Blk. female and both tail slapped one another. Following this the Bu. female mounted the Blk. female and attempted to bite her in the neck region. On July 25, the Wh. female challenged then tail slapped the Or. Sp. male, forcing him to retreat. On August 14, the Yel. male displayed at, then challenged the Wh. male and tail slapped him three times, forcing him to retreat. On August 15, the interaction involved the Wh. female and the Wh. male. The female was the aggressor and after a long series of tail slappings, mostly by the female, the male retreated. This encounter was recorded in slow motion on 16 mm. film and was analyzed to give the drawings in Figure 4. The Wh. female slapped the Wh. male at least 12 times during this encounter.

It is probable that tail slapping is important in establishing and maintaining dominance relationships within this species.

Courtship

There is no obvious sexual dimorphism in the desert iguana, but observations indicated some form of sexual recognition. Both males and females performed push-ups, but the males did so more vigorously and with greater change in body posture.

Action which indicated both tentative sex recognition and initiation of courtship behavior was the rapid nodding of the head. These were very shallow head nods, about 6 to 8 per second, and were performed in sequences of 1 to 2 seconds. Nodding was observed only in adult males. A male (usually just the dominant male) when approaching another passive individual frequently commenced the nodding and moved closer to the passive lizard. The lizard approached usually retreated, especially if a male. When retreat did not take place, the courting male then continued his nodding, moved up to the passive lizard and either nudged it near the cloaca or along the trunk, or walked over it. Such contacts usually stimulated the passive lizard to retreat. Retreating females often moved away slowly with the courting male following a few inches laterally, continuing his nodding as they moved along.

If a male could not make a close approach to a passive lizard he had been courting, he might then rush at this lizard and attempt to bite it, usually in the shoulder region. It was difficult to judge if such a charge with biting was intended as part of courtship or was an aggressive attack. Perhaps they are the same.

The courting male attempted to attain a grip on the shoulder skin of the courted individual. If he was successful, he brought his body parallel and over that of the courted individual. He then attempted to bring the cloacal regions together. The hind leg opposite to the side of the approach, was thrown over the base of the passive participant. No actual copulation was observed. When the shoulder grip was attained, one pair was observed to move away, one astraddle the other, to an area out of view beneath a log.

Nodding approaches were made toward both females and passive males. The males usually retreated. Some females so approached were observed to direct their swishing tails at the heads of the males as they moved away.

From the above actions, it appeared that sex recognition, at least at a distance, was dependent upon the response of the courted

lizard. The following behavior, however, which probably was related to courtship, indicates that both may be active in courtship.

Mutual Abdominal-Contact Behavior

The behavior here described was observed on six different occasions between June 17 and August 9, 1961. There was no apparent way to anticipate that such actions were about to take place. Both sexes were observed to take part actively and all but one observation involved a male and a female.

On June 17, at 9:15 a.m. the now dominant Or. Sp. male approached Bu. female, turned her over on her back, and crawled over her. After a few seconds pause he repeated these actions and the female retreated down a hole.

On July 12 at 7:55 a.m. the now dominant Wh. Sp. male approached the Wh. female, circled about her and then crawled on top of her, heading in the opposite direction. This female gave no response. The male then approached the Bu. male and circled about him. After circling, he approached the Bu. male face-to-face, walked along his left side and when his head was even with the hind leg of the Bu. male, he stuck his head under the body of the Bu. male and continued to walk on until their hind legs were even. The Wh. Sp. male in some manner, flipped the Bu. male over on his back and continued to walk on with the result that the ventral regions, especially the cloacal regions, were apparently rubbed together. The Wh. Sp. male made a wide circle and came back facing the Bu. male and repeated the above actions. At 8:05 a.m. the Wh. Sp. male approached and performed the same actions with the Bu. female. On July 26 at 10:45 a.m. the Wh. Sp. male repeated the above actions with the Blk. female, except that it appeared this female turned over on her back through her own efforts.

On August 2 at 10:30 a.m. the Wh. Sp. male flipped the Blk. female over on her back and crawled off rubbing the bellies together. He repeated this performance twelve times in succession, moving off and circling back to meet her each time. The female appeared very submissive and cooperative to the extent that, as the male's head approached her body, she raised her body from the ground as if to permit the male to get his head under her. The male paused a few times while over the inverted female, the abdomens in contact. The hemipenis was thought to have been seen briefly only once, but this was not certain.

On August 9, in the late morning, the female approached the male and walked along his side. The male stuck his snout under the hind leg of the female and flipped her completely over onto her back. The male then crawled over her, bringing the bellies together. The female then turned and circled back towards the male and began to crawl under his hind legs, and as she did this she turned herself belly-up and the male moved off from her. The female repeated her efforts four times in rapid succession, paused and then continued, each time thrusting her head under the hind leg of the larger male and as she started to crawl beneath him she proceeded to turn herself completely over as the male walked away from her in the opposite direction. At the completion of each contact both the male and the female circled sharply back toward one another, approached each other, and repeated these actions. All of this took place in an oval approximately 20 by 8 inches. In this series, the contact action was repeated seven times.

All of these mutual actions ended with the two participants going their separate ways. These actions may be a part of courtship, or preliminary to some other type of action. However, no male nodding was observed during any of these events.

Behavior of Juveniles

A number of the desert iguanas on hand in the spring were juveniles from the previous summer's hatching and were considerably smaller in size than the adults, measuring only 5 to 8 cm. in body length as compared to 12 cm. or more for the adults. These small lizards responded very frequently to the approach of another desert iguana, and also to other lizard species present by standing high on all for legs, with body compressed and dewlap extended, often laterally oriented. In this posture it usually strutted or walked away in a stiff-legged manner. One in this posture was observed to jump laterally about two inches when rapidly approached. Juveniles were observed walking across the enclosure in this stiff-legged manner, dewlap extended, when there appeared to be no immediate cause other than a resting lizard that they were moving by. These actions probably worked to protect the juveniles. They were not accompanied by push-ups.

Similar responses were observed in adults, but much less frequently.

Discussion

Norris (1953) observed that these lizards demonstrated preferences for particular burrows, by retreating to these burrows, and aggressively challenging intruders and chasing them away.

Such activities were vividly demonstrated in the enclosures used in this study. Displaying was frequent, but generally was limited to the individual (male) most successful in challenging and forcing the retreat of others. These challenges involved displays, chases and flights. The display varied in the intensity of its performance, but the pattern was the same for both the challenge display and the assertion display. The pattern was species-specific and probably functioned in species recognition and also for intimidation and the maintenance of dominance when the performance was a challenge display. The challenge displays, and often mere presence of the dominant, appeared to curtail the activities of other members of the group. It can be assumed that the dominant in the enclosure had declared this area as his territory and that his actions were similar to those of a desert iguana in nature where the territory most likely exceeded the size of the enclosure. The maintenance of a territory, or dominance in the enclosed group, depended on the continued ability of the dominant to assert himself by aggressively displaying and chasing other members. If this ability was lost, dominance was quickly taken over by another, e.g., when the Or. Sp. male became injured and the Wh. Sp. male became the dominant. Such shifts in dominance have been showed to be characteristic of the tree lizard, *Urosaurus ornatus*, by Carpenter and Grubitz (1960) and of *Anolis carolinensis* (Greenberg and Noble, 1944).

The desert iguana has developed the use of the tail as an organ for aggression. Such aggressive action is probably significant in establishing dominant-subordinate relationships between two combatants. Once dominance was established, the display of the dominant was probably sufficient to intimidate the subordinate into retreat or submission. In nature, tail slapping encounters probably occur infrequently because of the established territories and greater availability of living space. Such use of the tail may account for the frequent appearance of injuried and regenerating tails observed when these lizards are captured in the field.

No actual copulation was observed between any of the enclosed lizards, but courtship nodding was very frequent, especially by the dominant male. The occurrence of the peculiar behavior between a male and female in which the male crawled over an inverted female, rubbing the ventral areas together, indicated that courtship in this species involved more than nodding. This ritual performance appeared to be initiated by either partner, with both participating. Such behavior may serve as a mating stimulus in the absence of marked sexual color dimorphism, but needs further study.

Summary

A group of five female and nine male desert iguanas were observed in a large enclosure between June 10 and August 15, 1960.

During the species-specific challenge display, the male oriented his longitudinal axis parallel to the intended recipient, compressed his trunk, extended the dewlap and lowered the head. In this posture he performed a sequence of unit movements by extending and flexing the forelegs. The first unit consisted of a single high push-up, while the second and all following units had this single high push-up followed immediately by two rapid shallow push-ups. Each sequence performance had the same specific cadence. Females and juveniles and non-challenging males perform the same sequence of movements to the same cadence, but during these assertion displays there is no posturing and the amplitude of the movements is less exaggerated.

One large male quickly assumed the role of dominant in the group and accounted for the majority of aggressive activity such as displaying, chasing and courtship. When the dominant was injured, another large male quickly assumed dominance in the group.

Aggressive encounters sometimes involved repeated violent reciprocal tail slapping, the tail being used to whip one side of the opponent while the head and truck were flexed rapidly towards the other side.

Courting males perform very rapid shallow head nods when in the presence of a female. During copulation, the male maintains a biting hold on the skin of the shoulder of the female. A peculiar performance, possibly related to courtship, involved the male rubbing its abdomen with that of an inverted female.

the action being initiated by either individual.

Juveniles responded to the approach of other lizards by posturing.

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The Middle Ear of *Holbrookia* and *Callisaurus*

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It is generally agreed that the sand lizards (*Holbrookia, Callisaurus,* and *Uma*) have evolved from a single prototype. According to Norris (1958) and Savage (1958) *Uma* arose first as an offshoot of this early stock and *Holbrookia* and *Callisaurus* were separated later.

Smith (1946) groups these lizards and points out their general similarities in scalation, body form, and habitat requirements. The genus *Holbrookia* differs from the other two in lacking an external tympanum.

Superficially *Holbrookia texana* is more similar to the genus *Callisaurus* than to the other members of the *Holbrookia* group. Except for the absence of an external tympanum it might easily be mistaken for a *Callisaurus.* Axtell (1958) has suggested that "earlessness" has evolved twice in the sand lizard group, once producing the genus *Holbrookia* and a second time producing the *Callisaurus*-like *Holbrookia texana.* The purpose of the present investigation is to compare the morphology of the middle ear of *Callisaurus* and *Holbrookia* with the expectation that this may clarify the phylogenetic position of *H. texana.*

Materials and Methods

The forms used in this study were as follows: *Callisaurus draconoides ventralis* (4), *Callisaurus draconoides gabbi* (2), *Callisaurus draconoides ventralis* × *gabbi* (4), *Holbrookia bunkeri* (2), *Holbrookia lacerata subcaudalis* (2), *Holbrookia maculata approximans* (3), *Holbrookia maculata elegans* (2), *Holbrookia maculata maculata* (6), *Holbrookia maculata thermophila* (3), *Holbrookia propinqua propinqua* (4), *Holbrookia texana texana* (6), and *Holbrookia texana scitula* (6). The same techniques were employed as those described by Earle (1961a). The terminology used in describing the musculature is that of Edgeworth (1935).

Results

The skeletal elements. The quadrate of *Holbrookia* and *Callisaurus* arches anteriorly and ventrally from its dorsal articulation with the squamosal, supratemporal, and crista parotica to terminate ventrally in a double condyle. Ventrally the quadrate articulates with the articular and medially it articulates with the pterygoid. A strong ligament extends posteriorly from the prootic bone to attach to the dorsomedial surface of the quadrate (Figures 1 and 2). A concave auditory cup or conch is present on the posterolateral surface of the quadrate of both *Holbrookia* and *Callisaurus* and a laterally projecting flange is present on the anterior edge of the quadrate. The posterior edges of the quadrates of both *Holbrookia* and *Callisaurus* are notched as far down as the pterygoid to receive the expanded knob of the extracolumella and are lined by an articular cartilage. This cartilage is enlarged in *Holbrookia* (compare figures 1, 2, and 3). The

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Fig. 1. Transverse section of *Holbrookia maculata approximans* showing the articulation of the left extracolumella with the quadrate.

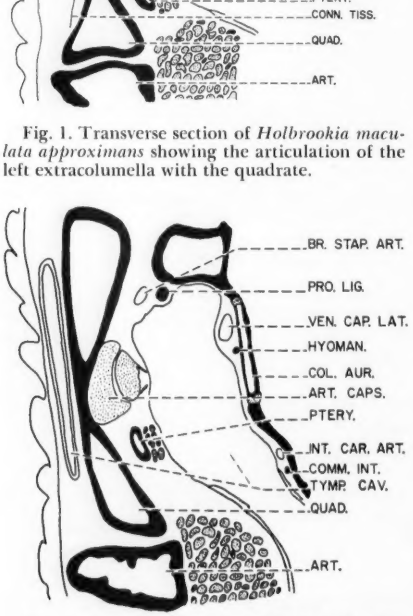

Fig. 2. Transverse section of *Holbrookia texana scitula* through the same region as that of figure 1.

quadrate notch of *Holbrookia* extends onto the lateral surface of the quadrate while that of *Callisaurus* involves only the posteromedial surface of that bone. The ridge of the crista parotica of *Holbrookia* and *Callisaurus* projects from the lateral surface of the opisthotic to terminate ventrally and anteriorly (not posteriorly, Earle, 1961a) at the processus paroticus of Rice (1920). In lizards possessing a dorsal process of the columella auris this process will project upwards to the processus paroticus.

The columella auris of all specimens studied is basically similar. The footplate, occupying the fenestra ovalis, is circular to oval and is completely ossified except at the periphery. The medial surface of the footplate of *Callisaurus* is concave. That of *Holbrookia texana* exhibits some concavity while in the other *Holbrookia* this region is relatively flat and rugose. The stalk of the columella auris is equally thickened in all specimens and projects laterally and anteriorly from the footplate. The attachment of the stalk to the footplate is off center toward the anteroventral edge of the footplate and the bony part of the stalk is continuous with the cartilaginous extracolumella.

In both genera the extracolumella is expanded into a knob articulating with the posterior surface of the quadrate. As mentioned, the quadrate notch receiving this knob, is more extensive in *Holbrookia* than in *Callisaurus* and the cartilaginous knob is correspondingly enlarged in *Holbrookia*. A process from the posterolateral surface of this knob extends to the lateral limit of the tympanic cavity and is expanded into an insertion plate in all forms examined.

The typical lacertilian insertion plate, lying in the tympanum, has been described by de Beer (1937). This plate is "X" shaped. The upper left arm of the "X" is the pars accessorius anterior, the lower left arm is the pars inferior, the upper right arm is the pars superior, while the lower right arm is the pars accessorious posterior. In *Holbrookia maculata* it has the appearance of a dorsoventrally lengthened diamond, widened at its point of attachment to the extracolumella. The insertion plates of *H. bunkeri*, *H. lacerata*, and *H. propinqua* are nearly vertical processes. The pars superior of these forms is elongated and directed posterodorsally. The insertion plates of the above mentioned forms lie in a fold of the tympanic membrane posterior to the quadrate, or may slightly overlap its posterior edge. In the adults studied no contact is made between the insertion plate and the ceratohyal. In section connective tissue can be seen extending from the insertion plate to the quadrate and the articular.

The insertion plates of *Callisaurus* and *Holbrookia texana* lie essentially lateral to the auditory cup of the quadrate. In both of these forms the insertion plate is wider than those of other *Holbrookia*. That of *H. texana* is oval and tipped posteriorly. A short posteroventrally directed pars accessorius posterior extends from the middle of the oval. A pars accessorius anterior projects in the opposite direction and is continuous with a minute ligament which extends to the dorsal part of the quadrate. The anterior part of the insertion plate of *H. texana* lies between the tympanic membrane and the lateral scales

while its posterior edge is covered by the depressor mandibulae anterior.

Like *Holbrookia maculata*, the shape of the insertion plate of *Callisaurus* approaches that of a diamond but is much wider across the middle and lies between the two layers of the tympanum. The pars accessorius posterior is lengthened and is continuous with a ligament. This ligament is similar to that of *Ctenosaura* (Oelrich, 1956) and extends posteroventrally to border the tympanic membrane posteriorly. The pars accessorius anterior of *Callisaurus* is similar to that described for *Holbrookia texana*.

An extracolumellar ligament, present in all specimens of *Holbrookia* and *Callisaurus* used in this study, extends ventrally from the processus paroticus and anterolaterally passing beneath the arched dorsal portion of the quadrate. It then passes down over the insertion plate of the extracolumella as in *Holbrookia maculata* (Earle, 1961b).

A dorsal process is observed in sections of *H. bunkeri, H. lacerata, H. maculata approximans, H. propinqua,* and *H. texana*. This process projects dorsally, medially, and posteriorly from the cartilaginous extracolumella at its junction with the bony stalk of the columella auris. The dorsal process parallels the extracolumellar ligament and is attached at the processus paroticus. An internal or quadrate process is not observed in any of the specimens studied.

The tympanic cavity and membrane. Both *Callisaurus* and *Holbrookia* have a well developed tympanic cavity which is in communication with the pharynx by means of the Eustachian tube. The tympanic cavity is lined by the tympanic membrane and all structures described as passing through the cavity are actually enfolded in this membrane. The tympanic cavity of *Callisaurus* is typical for that of a lizard possessing an external tympanum. Lateral to the auditory cup of the quadrate it extends anteriorly as a blind pouch as far as the flange of this bone (Fig. 3). The external layer of this pouch is met by the outer layer of skin forming the double layered tympanum and, as mentioned, the insertion plate of the extracolumella is imbedded between these two layers. The tympanic cavity of *Holbrookia texana* is similar to that of *Callisaurus*; however the anterolateral surface of the pouch is overlaid by scales and posteriorly it is slightly restricted by the anterior edge of the depressor mandibulae anterior.

The tympanic cavity of the other *Holbrookia* is essentially as described by Earle (1961a) for *H. maculata maculata*. The cavity

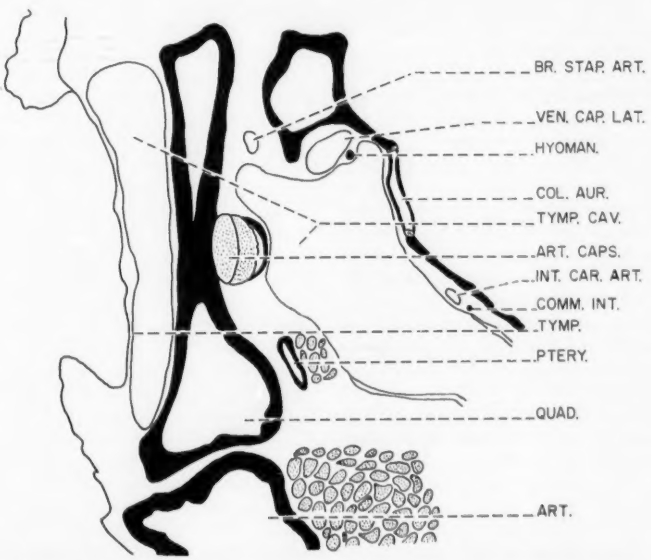

FIG. 3. Transverse section of *Callisaurus ventralis draconoides* × *gabbi* through the same region as that of figure 1.

and membrane of these specimens does not extend over the auditory cup of the quadrate (Fig. 1). In sections of *H. bunkeri, H. m. approximans* and *H. m. elegans* a greatly reduced anterolaterally projecting diverticulum of the tympanic cavity is seen. A thin sheet of connective tissue stretching over the auditory cup of the quadrate may represent a vestigial tympanic membrane (Fig. 1) similar to that of *Phrynosoma m'callii* (Norris and Lowe, 1951).

Muscles of the ear region. The constrictor colli of *Holbookia* and *Callisaurus* is a delicate and comparatively narrow band running across the throat and inserting on the dorsal fascia of the neck at about the level of the eye.

In *Callisaurus* the depressor mandibulae anterior forms the posterior boundary of the tympanum and arises from the squamosal and posterolateral process of the parietal. The depressor mandibulae anterior is continuous with the depressor mandibulae posterior which has its origin from the dorsal surface of the neck as far as the level of the axilla. The fibers of these two muscles converge to insert at the articular. A posterior slip of the depressor mandibulae posterior inserts on the fascia of the lower jaw.

The depressor mandibulae of *Holbrookia* is similar to that of *Callisuarus* except for the origin of the anterior fibers of the depressor mandibulae. In *Holbrookia bunkeri, H. lacerata, H. maculata,* and *H. propinqua* these anterior fibers arise from the undersurface of the dorsal part of the laterally projecting flange of the quadrate. The anterior edge of this muscle borders this flange and covers the auditory cup of the quadrate (Fig. 1).

In *Holbrookia texana* only a few of the anterior fibers of the depressor mandibulae take origin from the quadrate. These fibers arise from only the posterodorsal tip of the quadrate and descend to insert on the articular. The depressor mandibulae anterior does not border the quadrate flange and the auditory cup is not covered by this muscle (Fig. 2).

The capiti-cleido-episternalis and capiti-dorso-clavicularis of *Holbrookia* are similar to those of *Callisaurus.* Both muscles arise beneath the depressor mandibulae. The capiti-cleido-episternalis arises dorsal to the quadrate from the posterior part of the skull and neck and extends posteroventrally to insert on the sternal region. The origin of the capiti-dorso-clavicularis is continuous anteriorly with that of the capiti-cleido-episternalis. The capiti-dorso-clavicularis arises from the dorsal surface of the neck back to the level of the fore-leg. Its fibers converge ventrally to insert over the shoulder.

A laxator tympani muscle described by Versluys (1898) as extending from the processus paroticus to the extracolumellar ligament was not observed in any of the forms studied.

The vessels and nerves of the middle ear. The vessels and nerves traversing the tympanic cavity of *Holbrookia* and *Callisaurus* do not appear to differ from those described for the Lacertilia in general by Goodrich (1930). The vena capitis lateralis enters the tympanic cavity on its dorsal surface. As it proceeds posteriorly through the cavity it assumes a position on the dorsomedian wall of the cavity and passes over the columella auris (see Figures). Posteriorly the vena capitis lateralis passes out of the tympanic cavity on its dorsal surface.

The internal carotid artery runs anteriorly through the tympanic cavity on its medial wall to pass ventral to the footplate of the columella auris (see Figures). After passing ventral to the geniculate ganglion this artery enters the vidian canal described by Romer (1956). The stapedial artery arises from the internal carotid artery as it passes below the footplate of the columella auris. The stapedial artery runs dorsally and laterally in a diagonal direction across the tympanic cavity. It passes over the stalk of the columella auris and out of the roof of the tympanic cavity to proceed anteriorly in the cranioquadrate space.

In both genera the geniculate ganglion of the facial nerve lies outside the facial foramen of the prootic bone at the anterior part of the auditory capsule. The palatine ramus of the seventh nerve runs anteroventrally from the geniculate ganglion to enter the vidian canal with the internal carotid artery. The hyomandibular nerve runs posterodorsally from the ganglion to assume a position ventral to the vena capitis lateralis and dorsal to the columella auris (see Figures). In the adult specimens of both *Holbrookia* and *Callisaurus* the hyomandibular nerve runs posterolaterally over the stalk of the columella auris, passing posterior to the stapedial artery. Just lateral to this artery the chorda tympani arises from the hyomandibular and proceeds anteriorly and ventrally down the posterior surface of the quadrate to penetrate the articular. As indicated by Earle (1961a) the chorda tympani in young *H. m. maculata*

(head length 5 mm.) separates from the hyomandibular medial to the stapedial artery and both nerves run divergent courses across the tympanic cavity. This same pattern is observed in young *H. texana* (head length 6 mm.). The hyomandibular proceeds posteriorly down the lateral wall of the tympanic cavity and ramifies to the muscles of the neck.

The glossopharyngeal nerve of *Holbrookia* and *Callisaurus* emerges from the lateral aperature of the recessus scalae tympani, the homologue of the fenestra rotunda of mammals (de Beer, 1937). The secondary tympanic membrane covering this opening of all forms studied is not strongly developed. According to Brock (1940) the lack of development of this membrane is correlated with degeneration of the ear. Communicating rami between the ninth and seventh nerves, are seen in all specimens. The ramus communicantes externus of Willard (1915) runs anteriorly from the glossopharyngeal nerve to contact the hyomandibular branch of the seventh nerve. It then proceeds out of the tympanic cavity with the stapedial artery. The ramus communicantes internus (see Figures) runs anteriorly, with the internal carotid artery, to the geniculate ganglion.

Discussion and Conclusions

As stated, because of the resemblance of *Callisaurus* to *Holbrookia texana*, it has been postulated that "earlessness" has arisen twice within the sand lizard group. On the basis of ear morphology alone *Holbrookia texana* appears to possess characteristics of both *Callisaurus* and the other *Holbrookia*. The comparatively unrestricted lateral tympanic pouch and the broadened insertion plate and concave footplate of the extracolumella of *H. texana* resemble the conditions found in *Callisaurus*. The extent of lateral notching of the quadrate, the articular cartilage therein, the partial restriction of the tympanic membrane by the depressor mandibulae and its covering by scales indicates a closer resemblance to the genus *Holbrookia*. On these grounds it is possible that Troschel (1852) was correct in assigning *H. texana* to the genus *Cophosaurus*. However, according to Maslin's (1952) principle of heterochronic parallelism, "related forms possess the potentiality for the development of identical clines, and under similar environmental conditions identical clines may develop at different times or in separate geographical areas."

Various authors (Norris, 1958, Axtell, 1958) place the origin of this group in a sandy, arid habitat. The similarities of ear structure of *Holbrookia texana* to the other members of the genus *Holbrookia* may represent parallel evolution because of similar environmental conditions and "earlessness" may have evolved twice. Further judgement is withheld until anatomical work being done by Dr. Jay M. Savage (in correspondence) has been completed.

During the development of the lacertilian columella auris a cartilaginous internal process is developed connecting the extracolumella to the quadrate (Goodrich, 1930). It is possible that the expanded knob of the extracolumella of *Holbrookia* and *Callisaurus* represents the internal process in these forms.

In a previous paper Earle (1961a) suggested that the adaptation to burrowing in *Phrynosoma m'callii* (Norris and Lowe, 1951) and *Holbrookia maculata* involved a similar enlargement of the depressor mandibulae anterior muscle. This muscle, described by Earle (1961a) for *H. maculata*, was inadvertently mistaken for the cervicomandibularis muscle of *P. m'callii* (Norris and Lowe, 1951). They also point out that the cervicomandibularis has enlarged because of selective factors involving the burrowing habits of *Phrynosoma m'callii*. This enlargement has forced the depressor mandibulae forward to cover the auditory cup of the quadrate. In the genus *Holbrookia* the depressor mandibulae and cervicomandibularis of Norris and Lowe (1951) are represented by the depressor mandibulae anterior and posterior; that is, these two muscles are not separated into two distinct muscles. Recently a specimen of *P. m'callii* (University of Colorado Museum No. 13266) has been dissected and the position and extent of the depressor mandibulae anterior and posterior were compared with that of *Holbrookia*. It is apparent that the depressor mandibulae anterior is not the "burrowing muscle" of *P. m'callii* as it extends from the posterior part of the skull to the lower jaw. However, in *Holbrookia* the most posterior fibers of the depressor mandibulae anterior arise from the dorsal surface of the neck continuous with those of the depressor mandibulae posterior and both anterior and posterior parts of this muscle could be used as a "burrowing muscle". The same selective forces may have been operative because of the arenaceous habitat of *P. m'callii* and *Holbrookia* but in a slightly different manner.

Summary

The anatomy of the ear region of the genera *Holbrookia* and *Callisaurus* are compared.

In both genera the columella auris is thickened and terminates in a knob articulating with the posterior surface of the quadrate. The knob and quadrate notch receiving this knob is larger in *Holbrookia* than in *Callisaurus*.

The extracolumella of both genera bears a laterally directed process which joins the tympanic membrane and is expanded into an insertion plate. The insertion plate is broad in *Callisaurus* and *Holbrookia texana* while it is reduced to a comparatively narrow process in the other *Holbrookia*.

The tympanic cavity of *Callisaurus* and *Holbrookia texana* is of equal extent and extends anteriorly to the quadrate flange. In the other *Holbrookia* it does not approach this limit.

The depressor mandibulae anterior does not cover the auditory cup of the quadrate of *Holbrookia texana* as it does in the other *Holbrookia*.

The nerves and vessels traversing the tympanic cavity follow the typical lacertilian relationships.

It seems likely that "earlessness" has evolved twice in the sand lizard group and that *Holbrookia texana* represents an "earless" *Callisaurus*.

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Abbreviations Used in Figures

ART., articular
ART. CAPS., articular capsule of the extracolumella
BR. STAP. ART., branch, stapedial artery
COL. AUR., footplate, columella auris
COMM. INT., ramus communicantes internus
CONN. TISS., connective tissue of the vestigial tympanum
DEP. MAND., depressor mandibulae anterior
HYOMAN., hyomandibular branch of the seventh nerve
INT. CAR. ART., internal carotid artery
PRO. LIG., prootic ligament
PTERY., pterygoid
QUAD., quadrate
TYMP., tympanum
TYMP. CAV., tympanic cavity
VEN. CAP. LAT., vena capitis lateralis

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A Suggested Function of the Ornamentation of East African Forest Chameleons

A. Stanley Rand

Hillenius (1959) concludes that certain characters in the genus *Chamaeleo* are without selective value. Among these he lists "ventral, dorsal, cranial crests, tarsal spurs, body squamation, etc."

Many species of *Chamaeleo* do indeed have structures whose functional significance is difficult to interpret in terms of the way these animals make their living. These structures or ornaments are frequently conspicuous and add to the bizarre appearance of these lizards.

I would like to suggest that some of them, at least, have a social significance and may be important in species recognition, and that they are analogous to the bright feathers and songs of birds, to the calls of frogs, and to the strikingly colored gular fans in iguanid lizards such as *Anolis*. Hillenius mentions this possibility but dismisses it.

The East African mountain species of *Chamaeleo* were examined in an attempt to assess the plausibility of this hypothesis. Loveridge (1957) records 18 species of *Chamaeleo* from Kenya, Tanganyika and Uganda. In an earlier paper, Loveridge (1937) discussed the ecology of these species and stated that 14 of them occur in the mountain forest. In Figure 1 I have indicated the main mountain areas.

In these 14 species there are six types of ornaments:

1. Annulated horns are true horns with a bony core and a keratinized sheath. In five species there are three such horns, one on the rostrum and one in front of each eye.

2. Occipital lobes are scale-covered flaps of skin growing posteriorly from the posterior, dorsal border of the head; they may be separate or joined medially. It has been reported that in certain species, at least, they are erectile. They occur in six species.

3. High dorsal fins are supported by elongated neural spines. They occur in two of the largest species and increase the apparent size considerably.

4. Lateral spines are enlarged scales shaped like elongate cones. They occur on the sides of two species.

5. Rostral projections are scale-covered and may be either single or double. They occur in five species.

6. Long double gular crests are composed of elongated conical scales arranged in two longitudinal rows along the throat. Short crests occur in several species, long crests in only one.

Though these structures usually show little if any sexual dimorphism, at least two of them, annulated horns and rostral projections, may be more highly developed in the male than in the female.

In Table 1 the main mountain areas in East Africa are listed; four in southwestern Tanganyika are grouped together on the basis of geographical proximity and faunal similarity. Under each area the species occurring there and the ornamentation in the males are indicated.

All but one of these ornaments are shared by two or more species, but in only three cases do two species have exactly the same ornamentation. These cases are *johnstoni* and *jacksoni*, *goetzei* and *bitaeniatus* (part), and *fülleborni* and *tempeli*. In each case the species having the same ornaments are allopatric.

Males of species occurring together are easily distinguishable on the basis of their ornamentation. Thus these characters could be used by these chameleons to recognize males of their own species.

Though seven of these 14 species have more than one kind of ornamentation, only one of them, *C. deremensis*, differs from all the species sympatric with it by more than one kind of ornamentation. *Chamaeleo fischeri* populations with both a rostral projection and a dorsal fin occur in four areas. In two of these areas the sympatric species lack both of these ornaments. However, in the third area, a dorsal fin occurs in another species, and in the remaining area both types of ornaments occur in other species.

Thus these species, with one exception (*C. deremensis*), are no more different from one another than they need to be to recognize one another on the basis of ornamentation. If the function of ornamentation were species recognition, selection would act strongly to produce conspicuous difference between sympatric species. Once these species were conspicuously different, there would be relatively little selection pressure for addi-

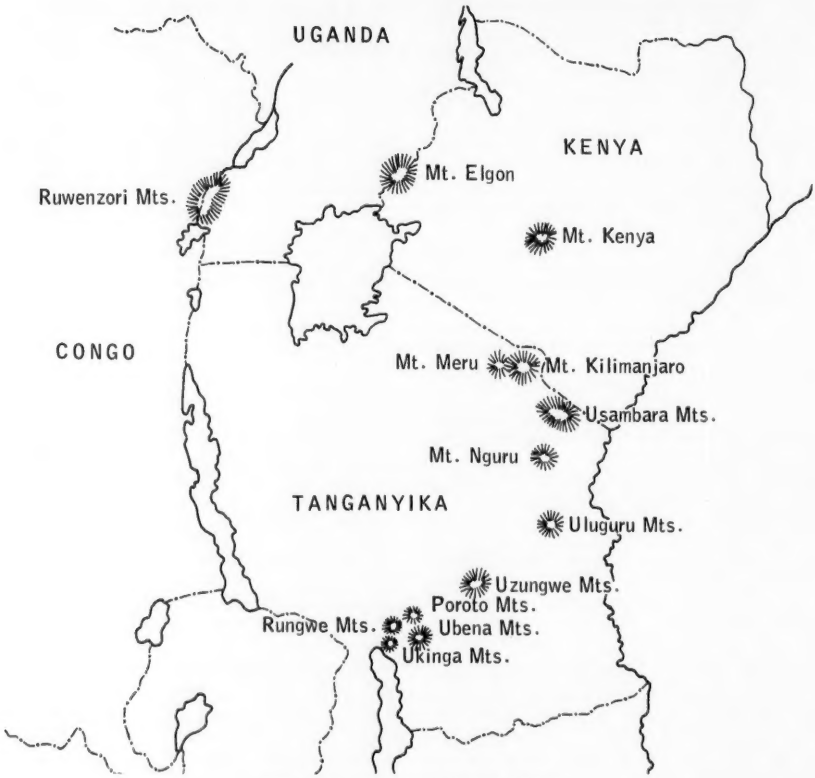

Fig. 1. Mountain areas in East Africa

tional differences. If the first difference were sufficiently useful in species recognition, additional species recognition characters would be less important and consequently not as strongly selected for.

Sympatric species usually have no more differences in ornamentation than is necessary for species recognition, but they do have similarities in ornamentation that cannot be useful in species recognition.

In four of the 10 areas, the same type of ornament occurs in more than one species. Occipital lobes occur in three species in the Ubena-Ukinga-Rungwe-Poroto area, in three species in the Uzungwe area, and in two species in the Uluguru area. Rostral projections occur in two species, both in the Usambaras and in the Mt. Kenya area.

Presumably when two similarly ornamented species occur together, selection acts to make them different by producing additional ornamentation on one or both of them, rather than by reducing ornamentation in either of them. It is apparently evolutionarily easier to add new ornaments than to remove those already present.

In every case where the behavior of closely related sympatric vertebrates has been closely examined, it has been shown that the females, at least, can recognize the males of their own species. Frequently the cues utilized are best developed in the males as are some of the chameleon ornaments discussed here. In visually oriented animals, these cues are usually visual and at least intermittently conspicuous. Chameleons are primarily, if not entirely, visually oriented animals, and these ornaments are the most conspicuous visual differences between the sympatric species. According to Walls (1942) chameleons have color vision, but in the absence of any useful information on the color in life of these species,

TABLE 1. ORNAMENTATION IN EAST AFRICAN MOUNTAIN FOREST CHAMELEONS

Area	Species	Ornamentation					
		Three annulated horns	Well developed occipital lobes	Dorsal fin	Lateral spines	Rostral projection	Long, double gular crest
Ruwenzori Mountains	johnstoni	×					
	bitaeniatus rudis						
	xenorhinus					×	
Mt. Elgon	bitaeniatus höhnelii					×	
Mt. Kenya	jacksoni	×					
	fischeri excubitor						
	bitaeniatus höhnelii					×	
Mt. Kilimanjaro	fischeri ssp.			×		×	
	bitaeniatus ssp.						
Mt. Meru	jacksoni	×					
	bitaeniatus ssp.						
Mt. Nguru	fischeri ssp.			×		×	
	bitaeniatus ssp						
Usambara Mountains	deremensis	×	×	×			
	fischeri ssp.			×		×	
	spinosus				×	×	
	tenuis						
Uluguru Mountains	werneri	×	×				
	fischeri ssp.			×		×	
	deremensis	×	×	×			
Uzungwe Mountains	werneri	×	×				
	goetzei						
	laterispinus		×		×		
	tempeli		×				×
Poroto, Rungwe, Ubena, and Ukinga Mountains	goetzei						
	incornutus		×				
	tempeli		×				×
	fülleborni	×	×				

it is impossible to evaluate the role of color in these animals.

This argument does not demonstrate conclusively that these "ornamental" structures are in fact used in species recognition. Proof must await behavioral observations and experiments. However, the hypothesis that they are so used does offer a functional explanation for them and, I feel, throws the burden of proof on anyone who claims, as Hillenius has done, that they are without selective value.

SUMMARY

An examination of the distribution of six bizarre structures or ornaments in the 14 species of mountain forest chameleons of East Africa shows that no two species have

identical ornamentation in areas where they are sympatric. This fact and other aspects of the distribution of ornamentation supports the hypothesis that these structures are of social significance, probably in species recognition and not, as Hillenius (1959) has suggested, without selective value.

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Description of a New Species of *Hyla* from Chiapas, Mexico[1]

William E. Duellman and Dale L. Hoyt

COLLECTIONS of frogs from the cloud forests on the eastern slopes of the Sierra Madre Oriental in Puebla and Veracruz have revealed the presence of numerous species of hylids, few of which have been found in the cloud forests in the Chiapan-Guatemalan Highlands to the east of the Isthmus of Tehuantepec. In the summer of 1960 we collected in the cloud forests on the northern slopes of the Chiapan highlands, where we found two species of *Hyla*, two of *Ptychohyla*, and two of *Plectrohyla*. Along a small stream cascading down a steep slope above Rayón Mescalapa we found on June 16, 1960, a small yellow *Hyla* that we first assumed to be *Hyla sumichrasti*. We returned to the same stream in August, at which time the frogs were calling. During the process of recording the call of this frog we noted that it produced two different calls; accordingly, we propose that this previously undescribed species be named:

Hyla bivocata, *sp. n.*

Holotype.—University of Kansas Museum of Natural History (KU) No. 58446, from a small stream above (6.2 kilometers by road south of) Rayón Mescalapa, Chiapas, México, elevation 1690 meters; one of a series collected on August 5, 1960, by William E. Duellman and Dale L. Hoyt.

Paratypes.—KU 58447–50, collected with the holotype.

Diagnosis.—A small yellow *Hyla* differing from other known species in México and Central America by the following combination of characters: broad flat head, pointed snout, indistinct tympanum, the diameter of which is less than one-third that of the eye, tongue attached behind and not notched posteriorly, a well-developed axillary membrane, a large dermal flap above anus.

Description of holotype.—Adult male having a snout-vent length of 28.5 mm.; tibia length, 14.6 mm., 51.2 per cent of snout-vent length; foot length (measured from proximal edge of inner metatarsal tubercle to tip of longest toe), 12.0 mm.; greatest width of head, 9.3 mm., 32.6 per cent of snout-vent length; head length, 8.9 mm., 31.2 per cent of snout-vent length; diameter of eye, 3.1 mm.; diameter of tympanum, 1.1 mm., 32.3 per cent of diameter of eye; interorbital distance, 3.5 mm.; width of eyelid, 2.6 mm., 74.3 per cent of interorbital distance. Head broad, flattened; canthus distinct, slightly curved concavely from eye to nostril; loreal region flat; snout pointed; an indistinct fold extending from eye to nostril; head slightly wider than long; diameter of tympanum about one-third the diameter of the eye; tympanum indistinct, covered by skin; a supratympanic fold from posterior corner of eye to a point above the insertion of forearm (Fig. 1). Fingers about one-half webbed; second and fourth fingers equal in length; subarticular tubercles round, well developed; a transverse fold of skin on wrist dorsally; pollex moderately enlarged, having a large, non-spinous, horny nuptial excrescence (Fig. 2A). Toes three-fourths webbed; inner metatarsal tubercle

[1] Seventh in a series of studies on American hylid frogs.

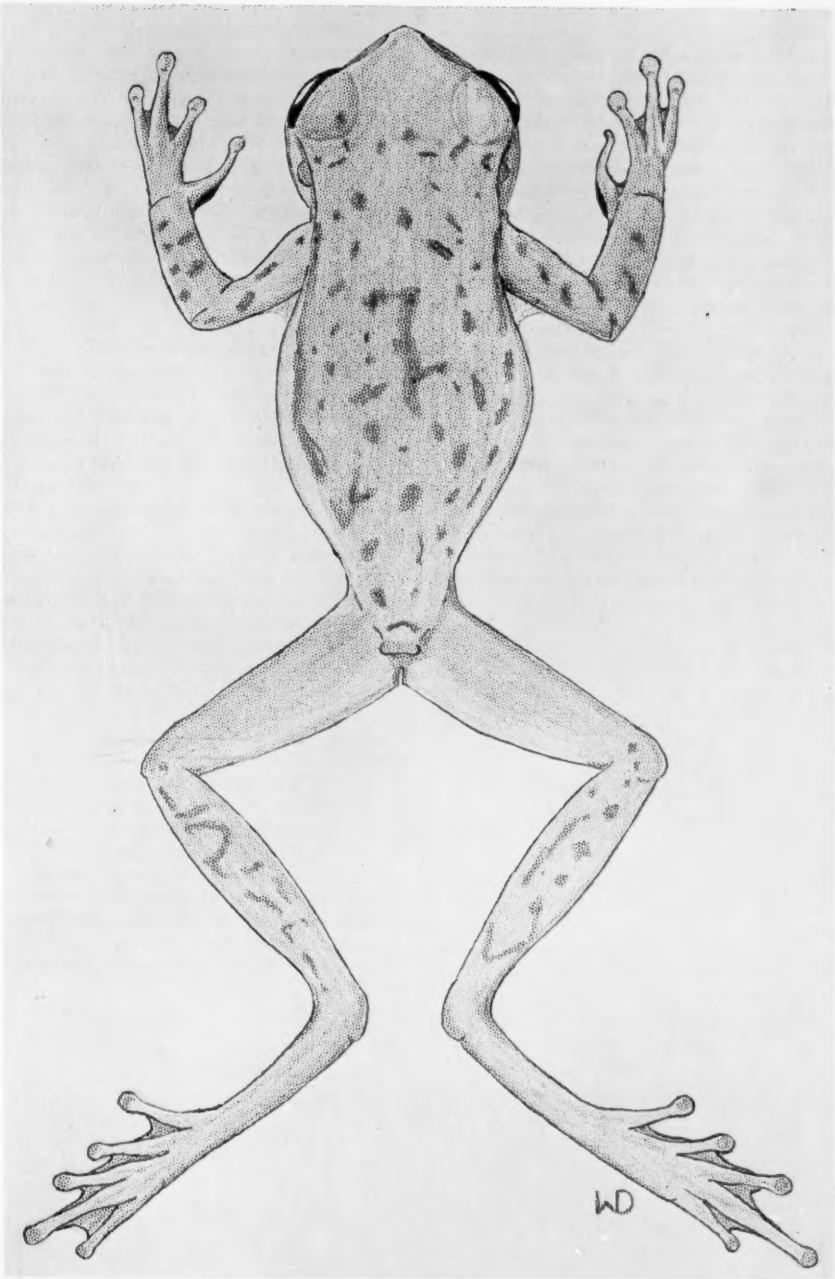

Fig. 1. Holotype of *Hyla bivocata* (KU 58446). × 3.5

elliptical, distinct; outer metatarsal tubercle absent; tarsal fold distinct; subarticular tubercles low and rounded, not prominent (Fig. 2B). Tibiotarsal articulation extends to middle of eye; heels of adpressed limbs overlap by 4 mm. Anal opening at dorsal surface of thighs; a large supra-anal flap; small tubercles on posterior surface of thighs and below anus. Skin of dorsum smooth; that of venter granular. A distinct axillary membrane extending about one-half length of upper arm. Vomers small, rounded, situated between the choanae, and widely separated medially; choanae half again as large as vomers; tongue attached posteriorly and only shallowly notched posteriorly; vocal slits large, situated lateral to the widest part of tongue; vomerine teeth 4-4.

Color (in alcohol) on dorsal surfaces pale tan; venter white; upper lips white spotted with melanophores; canthus dark; a black bar from eye to nostril above the naso-ocular fold; loreal region and snout darkly pigmented. Scattered dark spots on dorsum (Fig. 1). Flanks colored like dorsum; belly white with small scattered dark spots laterally; throat white. No conspicuous markings on dorsal surfaces of thighs; scattered dark brown markings on shanks; ventral surfaces of legs immaculate white. Arms and fingers 3 and 4 brown dorsally; nuptial pads pale brown; first two fingers white with scattered dark pigment. Feet brown dorsally and ventrally, except subarticular tubercles, which are unpigmented.

Color (in life, based on notes on entire type series) of dorsum yellow to pale tan; brownish or greenish flecks present or absent; preorbital bar dark brown; venter cream-color; vocal sac a cream color to pale yellowish white; iris gold.

Variation.—The following discussion of variation is based on data taken from the holotype, paratypes, and KU 58452 from 5.6 kilometers south of Rayón Mescalapa, Chiapas. In coloration, two specimens have only a trace of dark marking on the dorsum. One specimen is noticeably darker than the holotype and has more dorsal spotting. These six specimens, all adult males, have snout-vent lengths of 26.1 to 28.5 mm. (aver. 27.0). Variation in proportions are: tibia/snout-vent length, 0.512–0.549 (0.530); head width/snout-vent length, 0.326–0.364 (0.340); interorbital distance/head width, 0.352–0.444 (0.398); tympanum/eye, 0.276–0.323 (0.298). The number of vomerine teeth varies from 4 to 8 (aver. 6.2).

Mating Call.—The mating call of *Hyla bivocata* was recorded at the type locality on August 5, 1960. Recordings were made with a Magnemite Portable Recorder (Model 610-EV); sound-spectrographs were made by the use of a Vibralyzer (Kay Electric Co.). At the time of recording the air temperature was 66° F. The call of *Hyla bivocata* consists of a single long note followed immediately by a series of short notes, or only a long note, or only a series of short notes. The single

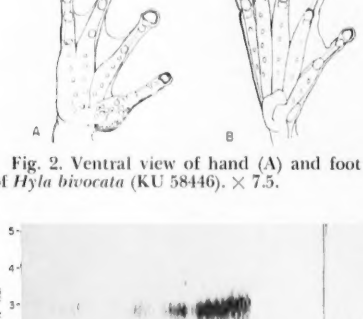

Fig. 2. Ventral view of hand (A) and foot (B) of *Hyla bivocata* (KU 58446). × 7.5.

Fig. 3. Sound-spectrographs of mating calls of *Hyla bivocata*. The single long note to the left and the series of short notes to the right were recorded from two different animals.

long note has a duration of 0.55 of a second, during which time there is an increase in the pulse rate and intensity. The frequency range of the long note is 2300 to 3500 cycles per second (c.p.s.). During the note there is an increase in the dominant frequency from 2750 to 2800 c.p.s. (Fig. 3). Series of short notes from two individuals were recorded. One of these frogs gave 17 notes in 14 seconds; the other gave 14 notes in 12 seconds (1.17 and 1.21 notes per second). The duration of each short note is 0.060 to 0.075 of a second. The frequency range is 1800 to 3300 c.p.s., and the dominant frequency is 2650 c.p.s.

Although several frogs of this species were heard, not many were observed calling, for the frogs were hidden in dense foliage on the steep bank above the stream. Most individuals observed produced only the series of short notes. One individual was observed repeatedly to emit only the single long note, and two individuals were observed to produce a long note followed by a series of short notes. Fouquette (1960:490) showed that *Hyla ebraccata* in the Panama Canal Zone produced a long note usually followed by a series of short notes. He stated that this species gave the compound call or only the single long note, but never the series of short notes alone.

Remarks.—The characters given in the diagnosis serve to separate *Hyla bivocata* from all other known Middle American species. Of other species of small yellow or pale tan *Hyla* in México and Central America, *ebraccata, microcephala, picta, robertmertensi,* and *smithi* breed in ponds. Of these species, only *ebraccata* has an axillary membrane, but it also possesses a dark brown hour-glass-shaped mark on the dorsum. Two other yellowish tan species occur in the Chiapan-Guatemalan Highlands. Of these, *Hyla sumichrasti* has a more blunt snout and shorter fingers than *bivocata*; further more, *sumichrasti* lacks an axillary membrane, dermal flap above the anus, and, usually, vomerine teeth. *Hyla bromeliacea* has large fingers and only vestigial webs between the fingers; the feet are about one-half webbed; the tongue is emarginate. Like *sumichrasti, bromeliacea* lacks an axillary membrane and dermal flap above the anus.

Examination of cleared and stained specimens of the eight species named above reveals that *Hyla bivocata* lacks a squamosal-maxillary arch and a quadratojugal but has a large frontoparietal fontanelle. All of the species lack a squamosal-maxillary arch. *Hyla bromeliacea, picta,* and *smithi* have a quadratojugal that articulates with the quadrate; *sumichrasti* has a short quadratojugal that is ligamentously attached to the quadrate. In the other species the quadratojugal is absent. In *Hyla ebraccata* and *robertmertensi* the frontoparietal fontanelle is completely roofed (or nearly so); in the other species the fontanelle is present.

On the basis of mating calls, ecology, osteology, and external features, only minor inferences can be made concerning the relationships of these species. *Hyla picta* and *smithi* certainly are closely related, as are *microcephala* and *robertmertensi*; *Hyla ebraccata* is related to *leucophyllata* and *reticulata* in South America. The relationships of *bivocata, bromeliacea,* and *sumichrasti* are unknown.

Acknowledgments.—We are indebted to John Wellman for his assistance in the field. This work was done under a National Science Foundation Grant (NSF-G9827).

Summary

A hylid frog from Chiapas, México, represents a new species, described herein as *Hyla bivocata.* The mating call characteristically consists of a single long note followed by a series of short notes; sometimes only the long note, or the series of short notes, is given. The relationships of *Hyla bivocata* are unknown.

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Report on a Bite by a Red Diamond Rattlesnake, *Crotalus ruber ruber*

GARY K. CLARKE

AT 1:45 PM on November 4, 1959, I was bitten by a red diamond rattlesnake, *Crotalus ruber ruber,* a species of Baja California and extreme southwestern California. No bites by this species with detailed records of early symptoms and treatment are on record.

Among the variable factors that influence the outcome of a venomous snake bite are the physical and psychological conditions, as well as the size, of both the snake and its victim. I weighed 154 pounds, was six feet tall and 20 years old. The snake was an adult male measuring approximately 132 cm. and weighing 2,572 g. It had been in my possession for 292 days. Previous to that it had been in captivity at the San Diego Zoological Garden for an undetermined period. During the 20 weeks immediately preceding the bite the snake ate an average of 155 g. of freshly killed rats or mice every seven days. It appeared to be in excellent health and well adjusted to captivity.

Since I had never manually extracted its venom, nor fed it a living animal, the venom glands were probably full. Just before the bite I noticed that the snake was changing fangs; on each side both the old fang and a reserve one were in a functional condition.

Considerable experience in handling rattlesnakes, copperheads, and water moccasins had given me a deep respect for them; I was always cautious and had suffered no previous bites.

Circumstances Surrounidng the Bite

Since I was compiling data on metabolic rate, I weighed all specimens periodically. Each venomous snake was placed in a cloth sack, an operation that two of us ordinarily completed in less than a minute, with a minimum of discomfort and anger on the part of the snake. On occasion I weighed them alone.

On November 4 my assistant was not available, so at 1:30 PM I draped the weighing sack over the back of a chair and opened the cage of the *Crotalus r. ruber.* Firmly grasping the snake behind the head with my right hand and at mid-body with my left, I attempted to place it in the sack. My unsuccessful efforts continued for about five minutes, during which time it was relatively calm. I then released my grip at mid-body in order to hold open the sack with my left hand, but the rattlesnake shook so violently that I had to again grip it at mid-body. Once more I tried to slip it into the sack, but it knocked the sack off the chair, gaping and erecting its fangs. Still holding the rattlesnake, I knelt down and straightened the sack with my teeth, trying to pull the sack over the snake. Again it tried to bite, erecting first one pair of fangs and then the other; on one occasion it closed its mouth with fangs erect, so that they remained on the outside and protruded below the lower jaw. I finally succeeded in placing the snake in the sack, twisting the top, and tying it. Then I stood, with the sack on the floor about 10 to 12 inches in front of me, holding the top of it with my right hand above the knot. Just as I prepared to lift the sack, the thoroughly enraged rattlesnake violently thrashed about, embedding its fangs in the inside of my left leg just below the knee. There was an immediate burning pain, extremely sharp and intense. The snake actually hung from my leg attempting to close his lower jaw in spite of the double thickness of cloth. Still holding the top of the sack in my right hand, I pulled it away from my body, freeing the fangs. As I did so, a seemingly large quantity of venom sprayed on the floor in a semicircle (the fangs still protruded through the sack). It was exactly 1:45 PM. Although in pain, I saw so much venom on the floor, the sack, and my trousers that I thought I had received only a small dose; I even contemplated continuing my work. Instead, I untied the sack, and returned the rattlesnake to its cage at 1:46 PM. Taking a snake bite first aid kit (B. D. Asepto Snake Bite Outfit No. 2006), I walked 45 feet to the nearest telephone, and called my immediate supervisor at 1:47 PM. Then I slowly walked 33 feet to the nearest chair and sat down. The bite was bleeding freely.

First Aid Treatment

At 1:48 PM I applied a rubber tubing tourniquet about 5 cm. above the fang marks. I then cleaned around the bitten area with an antiseptic solution and prepared the

rest of the kit for use. At 1:50 PM help arrived and Mr. M. S. made a single 4 cm. incision with a razor blade directly over the fang marks. Unfortunately, this incision was made in a transverse rather than in the prescribed longitudinal direction (Boys and Smith, 1959), a mistake resulting from excitement, lack of experience, and my sitting position. I immediately applied the metal rim-rubber bulb type of suction cup. Dr. W. H. brought the Wyeth Antivenin kit from the refrigerator. The suction cup proved very effective, as I observed small pieces of flesh being drawn out with the blood. Although a previous intradermal skin test for sensitivity to horse serum had resulted in a negative reaction, Dr. C. S. administered another one at 1:55 PM. I continued to apply suction.

An ambulance arrived at 2:00 PM. I was carried on a stretcher to the ambulance, which left the laboratory at 2:04 PM for the hospital four blocks away.

Emergency Room Procedures

I arrived at the emergency room at 2:07 PM, where Dr. G. K. was making preparations for treatment. The intradermal skin test now showed a negative result; another test also proved negative. There was some local swelling below the tourniquet, but no marked discoloration. For a brief period I felt a strange tingling in my ears.

The tourniquet was moved about three inches up my leg. At approximately 2:20 PM 5 cc. of antivenin was injected around the puncture, and 5 cc. intramuscularly in my left gluteus maximus; about 2:30 PM another 5 cc. was injected locally and an additional 5 cc. into the quadriceps muscle group. A second incision, 3.5 cm. long, was made at the upper limit of the swelling, 6 cm. above the original incision. The tourniquet was removed and I was given 1/6 grain of morphine. In addition, I received 40 units of ACTH and 0.5 cc. of tetanus antitoxin. Magnesium sulfate compresses were applied over the wounds, and I was removed from the emergency room and placed in a ward.

Record of Reactions and Treatment

The following account is taken from my notes of the incident:

November 4, PM, 3:15 Blood pressure 138/80 (Other blood characteristics are given in Table 1); temperature 99.2°; pulse 88; respiration 20.....3:30 Durycin 2 cc. IM in right buttock ... 4:00 Blood pressure 130/90.....5:00 Blood pressure 120/80 .....5:15 Second injection of morphine (1/6 grain)..... 5:30 First meal—broth and jello.... 5:35 Extremely weak; leg in pain. Dr. G. K. examined leg and noted marked increase in swelling around knee and lower leg; no evidence of systemic reaction; little swelling of thigh.....6:00 Blood pressure 120/80; pulse 94.....6:15 Another 10 cc. of antivenin injected into left gluteus maximus .....6:45 Morphine not very effective. Although pain relieved to slight extent, it still persists from just above ankle to middle of thigh. Whole leg now pulsating and extremely sensitive; physician's breath on it very painful.... 7:15 Blood pressure 130/84; temperature 98.6°.....7:18 Urinalysis showed pH of 7, specific gravity 1.016 .... 7:25 $MgSO_4$ compresses continued and ice packs applied.....8:25 Blood pressure 126/90; pulse 106.....8:37 Unable to control short, spastic muscular contractions in left leg.... 9:00 Blood pressure 130/90 .....10:25 Another injection of morphine (¼ grain).

November 5, AM, 12:20 Dozed a little; cannot get comfortable due to pain in leg; 50 mg. IM injection of Dramamine; blood pressure 136/76; pulse 104; respiration 20 .... 12:25 Nauseated; feel terrible..... 12:45 Temperature normal; dressing changed; $MgSO_4$ compresses and ice packs continued.....12:55 5 cc. of blood drawn .....1:01 Vomited entire contents of stomach. Have never felt so sick or such extreme pain. Nurse noted emesis of undigested food particles.....1:05 Blood pressure 134/80; pulse 96; respiration 16.....1:07 One injection of Dramamine.....2:00 and 3:00 Blood pressure 110/74; pulse 80.....4:00

Table 1. Laboratory Results of Hematology Analysis

Date	Hemoglobin (%/gm.)	Hematocrit (%)	White Blood Cells	Immature WBC	Lymphocytes	Monocytes
Nov. 5	107/16.6	48	9,200	1	13	14
Nov. 6	99/15.3	44	11,650	4	4	—
Nov. 7	99/15.3	45	11,200	1	25	5
Nov. 8	87/13.5	39	7,900	2	26	9
Nov. 9	86/13.2	39	7,450	1	22	9
Nov. 10	94/14.5	44	6,450	1	26	8
Nov. 11	99/15.3	48	9,050	1	24	8
Nov. 12	94/14.5	44	9,800	1	22	3
Nov. 13	94/14.5	44	7,450	—	30	3

Fig. 1 Thirty and one-half hours after bite, thigh at left, calf at right. First aid incision over fang marks at right; emergency room incision in center; three of six subsequent incisions around thigh at extreme left.

Blood pressure 116/76; pulse 80.....5:00 Blood pressure 120/86; pulse 80.....6:00 Blood pressure 110/78, pulse 76.....7:00 Blood pressure 110/80; pulse 72; respiration 16. New ice packs applied. Extremely long and painful night; cannot move without hurting leg.....7:15 Temperature 98°; pulse 80.....8:00 Approximately 15 cc. of blood drawn from left arm.....8:10 Breakfast: jello and tea. Not hungry; weak..... 10:30 Lower third of my left thigh swelling, but there is minimum discoloration..... Noon Lunch: Broth, crackers, jello and tea. Blood pressure 114/80.

PM, 4:00 Temperature 98.6°; pulse 70; 2 cc. of Durycin.....4:40 Two cc. of Penicillin injected.....5:15 Dinner of broth, jello, and tea.....8:05 Swelling has progressed to middle of thigh and extends to ankle. Calf is larger than thigh. Leg now showing ecchymotic discoloration... 8:07 Starting injection of 6 cc. of 1% solution of procaine anesthesia around middle thigh. Hypodermic needle very painful. Four minutes required .....8:13 Six longitudinal incisions made at intervals around thigh. Each about 1.5 cm. long. Skin seems to split at touch of scalpel. Local anesthesia has not taken effect in some areas and I feel extreme pain as incision is made.....8:16 Photograph taken. (Figure 1). Leg so sensitive that heat from flash bulb is painful....8:17 $MgSO_4$ compresses again applied over wounds.....8:30 Short clonic spasms over entire body.....8:50 Feel that I cannot endure this constant excruciating pain throughout left leg much longer..... 10:15 Received another 10 cc. of antivenin in left gluteus maximus, and 1 grain of morphine.

November 6, AM, 12:15 Blood pressure 118/76; pulse 76; respiration 18.....4:00 Blood pressure 124/84; pulse 76. Extremely painful to move, and cannot endure lying on back; even sheet hurts.....4:20 Dressing being changed. When they remove tape from legt it is painful and little by little they pull hair out.....8:00 Breakfast: jello and tea. Temperature 98.2°; pulse 78.....9:10 Buccal Varidase tablet.....9:45 One cc. injection of ACTH Gel (40 units) IM in right

buttock.....9:46 After approximately 20 unsuccessful attempts an intravenous infusion of Cortisone (invert sugar) begun: total = 1,000 cc.

PM, 12:15 Lunch: Broth, jello, and tea. Getting very hungry.....12:40 Buccal Varidase tablet.....1:30 Urinated for first time in 15.5 hours.....2:20 Urinated again; white in color. Urinalysis showed pH of 5, specific gravity of 1.021, and few epithelial cells .....4:00 Temperature 100.2°; pulse 82. Buccal Varidase tablet. Received 2 cc. injection of Durycin.....5:10 Dinner: Broth, jello, and tea.....6:30 Five cc. of blood drawn.....7:00 Dr. G. K. notes that swelling has not progressed any higher and that it may be softening some below knee..... 10:00 Pain reduced a little; leg still very sore.

November 7, AM, 6:43 Bowels moved for first time since November 3 ....7:30 One cc. of blood drawn.....7:50 Buccal Varidase tablet.....8:00 Temperature 98.4°; pulse 84 ....8:10 Breakfast: soft foods. ....10:30 Dressing changed. Jello.....11:00 Dr. R. T. examined leg. Foot elevated more. Leg and foot still swollen. Unable to straighten out or bend leg. All 8 incisions are open and draining. Skin is discolored—yellow, bluish-purple, green.....12:00 Noon Buccal Varidase tablet.

PM, 4:00 Temperature 99.4°; pulse 98 .....4:15 Penicillin 2 cc. Buccal Varidase tablet. Urinalysis showed pH of 6, specific gravity of 1.035, mucus, 2–4 WBC, occasional RBC, epithelial cells.... 5:00 Swelling diminished some extent. Dr. G. K. feels leg is improved; I feel it is very sore.....5:10 Dinner: Full meals and large servings from now on.... 8:00 Temperature 98.6°, pulse 78.....8:30 Dressing changed.....9:30 Buccal Varidase tablet.

November 8, AM, 4:45 Durycin 2 cc..... 8:00 ACTH ½ cc. (20 units). Buccal Varidase tablet. Temperature 98°; pulse 70.. . 8:30 Five cc. of blood drawn.....9:30 Dressing changed.....11:45 Urinalysis showed pH of 5 and specific gravity of 1.025.

PM, 4:00 Temperature 99°; pulse 104 .....4:35 Durycin 2 cc. Buccal Varidase tablet . 8:06 Declomycin 150 mg. capsule (antibiotic).....9:30 Swelling decreasing. Leg sore, but can bend it some. $MgSO_4$ compresses discontinued.

November 9, AM, 4:40 Durycin 2 cc..... 8:00 Temperature 98°; pulse 80. . 8:10 Five cc. of blood drawn ....8:45 and 12:00 Noon Buccal Varidase tablet.

PM, 4:00 Temperature 100°; pulse 98; Urinalysis showed pH of 6, specific gravity of 1.020, calcium oxalate crystals, occasional WBC.....4:10 Buccal Varidase tablet. Penicillin 2 cc.....8:30 Swelling reduced; leg now near normal. Able to go to bathroom with crutches. Leg feels very heavy and pains a great deal when upright.

November 10, AM, 4:00 Penicillin 2 cc. .....7:30 Temperature 97.2°; pulse 84..... 7:40 Two cc. of blood drawn for test.

PM, 1:30 Dr. G. K. examined leg. Pitting edema; discoloration persists; all eight incisions still open and draining.....1:45 Dressing changed. Furacin soluble dressing placed on wound.... 4:10 Temperature 99°; pulse 86; normal bowel movement.....4:53 Penicillin 2 cc. Urinalysis showed pH of 6 and specific gravity of 1.020.....10:00 Noticed rash on left hip, back of left hand, and right forearm. Hands and fingers swollen. Itching.

November 11, AM, 7:50 Two cc. of blood drawn.....8:00 Declomycin 150 mg. capsule (antibiotic). Temperature 97.6°; pulse 80 ...9:15 Terrible case of the hives. Dr. H. M., consulting physician, feels that urticaria most likely reaction to Penicillin, not horse serum.....9:35 Received 25 mg. of immediate and delayed reaction Pyribenzamine (antihistamine).

PM, 12:30 Dr. G. K. noted: "Patient developed rather severe generalized urticaria earlier this morning, but had 40 U ACTH intramuscularly—is now practically asymptomatic."..... 1:40 Declomycin 150 mg. capsule. Dr. G. K. discontinued daily dose of 400,000 units of Penicillin and ½ g. of Streptomycin as of this morning.....4:00 Temperature 98.6°; pulse 88. Urinalysis showed pH of 6, specific gravity of 1.026, and calcium oxalate crystals .....10:00 25 mg. of delayed reaction Pyribenzamine; 150 mg. capsule of Declomycin. Hives seem worse; breaking out on hips, right foot, and left thigh.

November 12, AM, 7:25 Hives not so bad, but still itch. 2 cc. of blood drawn.....8:00 Temperature 97.2°; pulse 90.....8:07 Declomycin 150 mg. and 25 mg. delayed reaction Pyribenzamine.

PM, 1:30 Still unable to straighten leg completely.... 2:00 Declomycin 150 mg. and 25 mg. of delayed reaction Pyribenzamine. Incision immediately over bite continues to drain; swelling diminished..... 4:00 Temperature 98.0°; pulse 98. Urinalysis showed pH of 5, specific gravity of 1.025, and calcium oxalate crystals.

November 13, AM, 1:25 Large bowel movement.....7:32 Two cc. of blood drawn

.....8:00 Temperature 98.0°; pulse 86..... 8:07 Declomycin 150 mg. and 25 mg. of Pyribenzamine.....10:10 Able to limp for short distance unsupported. Leg still shows discoloration, swelling, pitting edema; also, excessive fluid around knee. Leg is still sore.

PM, 1:00 Released from hospital. Will continue to take Pyribenzamine twice, Declomycin three times a day.

November 14, AM, 8:00 Covered with hives! Eyes almost completely swollen shut. Fingers are swollen so much can hardly write .....9:45 Dr. H. M. arrived. Received 40 mg. injection of Prednisilone Phosphate. Will take total of 21 tablets of Methyl Prednisilone (4 mg.) in next six days.

November 15, PM, 2:00 Hives not improved much.

November 18, PM, 1:45 Area immediately around bite still tender. Can walk fairly well now.

December 25, PM, 1:45 Incisions healed satisfactorily.

May 4, 1960, PM, 1:45 Have not experienced after effects except occasional itching around area of bite. Have eight scars on leg.

Discussion

Klauber (1956) divides venomous snake bites into: (1) legitimate, true accidents, and (2) illegitimate, those inflicted on persons who are deliberately handling poisonous snakes. My bite is in the latter category. The teeth of the lower jaw did not make contact with my leg since the rattlesnake was unable to close his mouth through the cloth sack and my trousers. Although the snake tried to bite, it was more of a stab.

Due to the large amount of venom that was discharged on the floor, my trousers, and the sack, plus what was injected into my leg, I feel there may have been an almost complete evacuation of the venom glands. Moreover, violent anger motivated the snake.

Pain from a rattlesnake bite varies with the species and amount of venom. Pain is more severe in bites by *Crotalus atrox* and *C. ruber ruber* (Russell, 1960). Judging by the pain and other symptoms, I received a large amount of venom.

Klauber (1956) rates the venom of *C. ruber ruber* as relatively weak. He also states that this species "is probably the mildest-mannered of all rattlesnakes" (p. 420).

Acknowledgments—I wish to express sincere appreciation to the following individuals for assistance during the incident: G. Keith Kennard, M.D. and Hugh W. McCaughey, M.D.; and William B. House, Martin N. Schuler, Curtis Sandage, Fred Baiocchi and Paul Shields, all of Midwest Research Institute. I am grateful to Paul Anderson and Harold Orel for helpful suggestions concerning the preparation of the manuscript, and to James Bertoncin for taking the photograph.

I also give particular thanks to my wife, Margaret, for her help and encouragement.

Summary

The author (male, 154 pounds, 6 feet tall, 20 years old) was bitten by adult male *Crotalus ruber ruber* (132 cm., 2,572 g.) on November 4, 1959. The snake bit through a sack and victim's trousers, imbedding both fangs below the knee. The bite occurred at 1:45 p.m.; a tourniquet was applied by 1:48 and a transverse incision made over the fang marks by 1:50. The victim was taken to a hospital and there received 30 cc. of antivenin between 2:20 and 6:45 p.m. An additional 10 cc. was administered at 10:15 p.m. on November 5. Swelling of the leg was great and pain was intense until November 7. Blood pressure was high during the first 24 hours after the attack but was lower thereafter. Body temperature rose slightly. Antibiotics were administered to guard against infection. The victim was released from the hospital on November 13 and was able to walk almost normally by November 18.

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Gobies of the Genus *Gillichthys*, with Comments on the Sensory Canals as a Taxonomic Tool

GEORGE W. BARLOW

THE original aim of this study was to investigate the relationship between the species of *Gillichthys* found in the northern part of the Gulf of California and the one which occurs on the Pacific Coast of California. Shortly it became clear that it would be necessary to redescribe the forms involved because of the inadequate state of the existing treatments. The need for redescription was apparent because of the confusion prevailing in the literature, and the discovery of many incorrectly identified specimens in various museums in California.

This confused situation was unexpected, for the species in question are abundant, easily collected, and occur in areas from which collections are readily available. The main source of difficulties revolves about the nominal status of the forms found in the upper Gulf of California.

During the course of this study, specimens were accumulated from various locations in the lower reaches of the Gulf and from the Pacific Coast of California. Thus it became possible to compare a roughly continuous series of populations of one of the forms from its northern- through its southern-most limits on the Pacific Coast, and on up through the Gulf of California. The details of this analysis will be published elsewhere. But the conclusions are incorporated into the opinions expressed in the paper at hand as to the nominal status of the species involved, as well as the range of variation cited in the descriptions.

Acknowledgments.—Space does not permit mentioning the many people who contributed in one way or another to the accumulation of the materials reported on, but to all of them I extend my warmest thanks. I would like to express my gratitude to Boyd W. Walker for his assistance and guidance during the progress of this study, and for his critical comments on the original manuscript. Thanks also are due Alice Boatright for preparing the illustrations, Gerta M. Barlow for assistance with the manuscript, and Wayne Baldwin for curatorial aid.

MATERIALS AND METHODS

This study was based almost entirely on specimens deposited in the Fish Collections of the University of California, Los Angeles. During the investigation I examined about 4,000 specimens of *G. mirabilis* and about 1,000 *seta*. Most of the material was accumulated during the period 1949–1958, except for earlier collections from Mission Bay and Punta Abreojos. The San Francisco Bay (Alviso Ponds) specimens were obtained from Sim's Bait Shop, Long Beach, California, and care was taken to verify the original source of this material. The paratypes of *Gillichthys detrusus* (SU 5432) were examined at the Stanford Natural History Museum.

All counts and measurements were carried out in accordance with the methods of Hubbs and Lagler (1949). To facilitate counting, small specimens were cleared and stained with potassium hydroxide and alizarin, and a few large specimens were photographed with X rays.

The exceptions to Hubbs and Lagler's methods of measurements are as follows:

Body Depth, Anterior.—The distance from the insertion of the first dorsal spine to the middle of the crease formed on the anterior side of the pelvic fin base when the pelvic fin is held at a right angle to the body of the fish.

Body Depth, Posterior.—The distance from the base of the first element of the second dorsal fin to the base of the first element of the anal fin.

Snout to Vent.—The distance from the tip of the upper lip to the vent.

Snout to Pelvic Fin.—The distance from the tip of the upper lip to the lateral point of attachment of the pelvic fin base to the body, determined when the pelvic fin is held at a right angle to the body.

Maxilla Tip, Height.—The greatest vertical distance at the tip of the maxilla.

Snout, Width.—The distance from the lateral side of the base of one anterior nares to that of the other.

Cheek, Length.—The shortest distance between the margin of the orbit and the posterior-ventral corner of the preopercle.

Caudal Fin, Length.—The distance from the midpoint of the posterior margin of the hypural plate to the tips of the central rays of the caudal fin.

Pectoral Fin, Length.—The distance from the point of attachment to the body of the

fleshy ridge on the top of the pectoral fin base to the farthest tip of the fin, when the fin is held against the body.

Pelvic Fin, Length.—The distance from the middle of the lateral point of attachment to the body of the pedicle supporting the pelvic fins to the farthest tip of the fin, when the fin is in its normal position, *i.e.*, roughly parallel to the axis of the body.

Anal Fin, Height.—The distance from the base of the last element of the anal fin to the tip of the second to last ray, when the fin is erect.

Genital Papilla, Width.—the greatest width, usually at the base.

Genital Papilla, Length.—The distance from the middle of the anterior base of the papilla to the tip.

Gillichthys

1864. *Gillichthys* Cooper, J. G., Cal. Acad. Nat. Sci., Proc. 3: 109. Type by original designation *G. mirabilis* Cooper.

1865. *Gillia* Gunther, A., Zool. Rec., 1864: 157. Suggested as grammatically correct substitute for *Gillichthys* Cooper.

1921. *Aprolepis* Hubbs, C. L., Mich. Univ. Mus. Zool., Occ. Pap. No. 99: 1. Type by original designation *A. barbarae* Hubbs. (*Aprolepis* = *Gillichthys* Cooper; Hubbs, C. L., Mich. Univ. Mus. Zool., Occ. Pap. No. 169: 3, 1926).

The genus *Gillichthys* Cooper is hereby restricted to the two species, *mirabilis* Cooper and *seta* (Ginsburg). Ginsburg included these species within the genus *Lepidogobius* Gill (type: *Gobius lepidus* Girard), a larger undefined assemblage of Eastern Pacific gobies. The inclusion of *Gillichthys* occurred in his description of *Lepidogobius seta* in 1938. He mentioned *seta's* close relationship with *Lepidogobius* (*Gillichthys*) *detrusus* (Gilbert and Scofield) (which was a new combination but not so stated). Since *detrusus* is not the type of *Gillichthys* is was not clear whether he meant to transfer the genus, as well as the species, to *Lepidogobius*. From the nomenclature in a later paper (Ginsburg, 1945), it seems he intended all the gobies of the Eastern Pacific related to *Lepidogobius* to be included within that genus. Unfortunately Ginsburg's conclusions as to the actual limits of *Lepidogobius* remain buried in his unpublished monograph of the American Gobiidae. But any discussion of *Lepidogobius*-like gobies of the Eastern Pacific would have to consider the following nominal genera: *Lepidogobius* Gill 1859, *Eucyclogobius* Gill 1862, *Gillichthys* Cooper 1864, *Typhlogobius* Steindachner 1879, *Evermannia* Jordan 1895, *Ilypnus* Jordan and Evermann 1895, *Quietula* Jordan and Evermann 1895, and *Lethops* Hubbs 1925. Differences in morphology, especially osteology and pore patterns, as well as considerations of life histories, are compatible with the recognition of *Gillichthys* as a distinct genus. Ginsburg apparently considered this to be a subgenus, so my action merely constitutes a difference of opinion about the level of relationship between the allies of *Lepidogobius,* not the limits of *Gillichthys.*

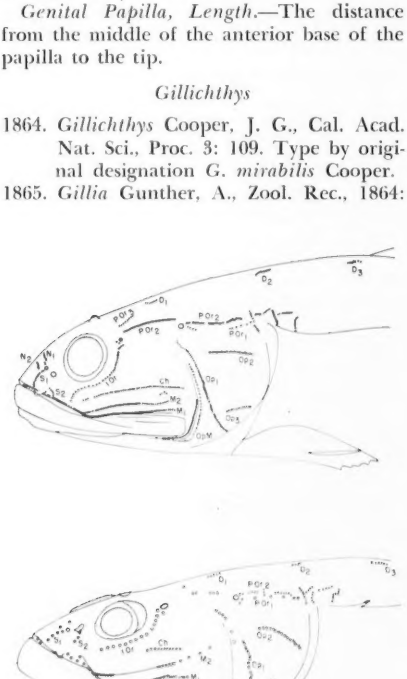

Fig. 1. Diagrammatic drawings of the arrangement of epipores and pores of the sensory canals on the heads of *Gillichthys mirabilis,* top, and *G. seta,* bottom (head of *seta* rotated slightly to show interorbital pore). Abbreviations for epipore system: *Ch* = cheek; $D_{1,2}$, and $_3$ = dorsal one, two and three; *I Or* = infraorbital; M_1 and $_2$ = maxillary one and two; N_1 and $_2$ = intranarial one and two; $Op_{1,2}$, and $_3$ = opercular one, two, and three; *Op M* = opercularmandibular; $P\ Or_{1,2}$, and $_3$ = postorbital one, two, and three; S_1 and $_2$ = snout one and two.

Diagnosis.—*Gillichthys* differs from related genera in the arrangement of mucous canals and their open pores on the head (Fig. 1). On each side of the head there is one pore just mesial to the posterior nares, one just posterior to the eye, and one where the line of the preopercle meets the skull. A median pore in the interorbital space (sometimes covered over) indicates the position of the interorbital canal.

Sphenotic with a slender, curved and pointed post-orbital process (absent in juveniles, develops with age), smaller in *seta* than in *mirabilis*. Model number of vertebrae is 32.

Description.—Body subcylindrical anteriorly, progressively compressed posteriorly. Head depressed and large, about 3 in standard length. From above profile of snout rounded. Top of head slightly concave. Lower jaw included. Anterior nares in a short tube immediately over upper lip, posterior nares just anterior to eye. Eye small, diameter less than interorbital space. Opercular opening runs from top of pectoral fin insertion downward and slightly forward to just beyond ventral insertion of that fin, margin of opening with membranous flap. Shoulder girdle lacks dermal papillae, but sometimes has slight membranous swellings. Gill-rakers blade-like and pointed near angle of gill arch, progressively reduced to nubs at each end of arch. Maxilla extends to preopercle or beyond in adults, slightly longer and posterior tip wider in males, posterior portion fleshy with many folds. Both upper and lower lips with a frenum. Tongue free only at tip. Genital papilla pointed in male, broad, sometimes almost bilobed in female; papilla larger during breeding season.

Teeth small, conical, inclined backwards, in a broad band of 4 to 5 irregular rows in each jaw; bands narrow posteriorly, terminate at vertical through anterior margin of eye. Pharyngeal teeth low and conical, set in fleshy pads. Dorsally two pairs, posterior pair of pads about five times larger than anterior, which they adjoin; each dorsal pair well separated medially, teeth progressively smaller from front to rear in posterior pair; one ventral pair of triangular pads, narrowly separated in midline, forms an "arrowhead" pointed anteriorly.

Body covered with irregular rows of small scales, largest on caudal peduncle, progressively smaller towards head, two to four vertical rows on base of caudal fin rays. No scales under pelvic fins near base, and anterior to vent for a distance equal to about one eye diameter. Scales denticulate in juveniles, posterior margins free; scales cycloid and imbedded in adults, occasionally some denticulate scales on sides between second dorsal fin and anal fin.

Pattern of epipores shown for both species in Fig. 1, more elaborate in *mirabilis*. Pores of sensory canals are also portrayed. A supraorbital canal follows superior margin of eye and opens out of pore mesial to posterior nares and out of pore posterior to eye; supraorbital canals connected by interorbital canal which usually opens through one mesial pore. Supraorbital canal continues posteriorly from postorbital pore and ends in pore over posterior margin of preopercle.

Pectoral fin rounded, tip reaching beyond tip of pelvic fins to vertical through middle of first dorsal fin, origin opposite origin of pelvic fins. Disc of joined pelvic fins oblong, sometimes rounded. First, or spiny, dorsal fin rounded and low, height about equal to anal fin base, variable; spines inclined obliquely to posterior, last spine attached by membrane to body at point one to two eye diameters before insertion of second dorsal fin. Last ray of second dorsal fin not connected to body by membrane; when depressed, tip of last ray does not reach caudal fin base. Anal fin about as high as second dorsal fin. Last ray free, not connected to body by membrane; when depressed, tip of last ray reaches vertical through tip of depressed second dorsal fin. Caudal fin truncate, corners broadly rounded, length equal to or slightly longer than pectoral fin.

Identification of the Species

The epipore and scalation characters should be used with caution if the specimens in question are less than 35 mm standard length. Smaller specimens, nonetheless, may be distinguished by the general arrangement of the epipores on the head (Fig. 1). Postlarvae may be separated by chromatophore patterns which are discussed later in this paper.

Key to the Species of *Gillichthys*

A narrow strip of scales on midline of nape; all rays of pectoral fin bound by membrane; epipores small and crowded; number increases with age, 15 to 40 or more in opercular row number three, 6 to 15 or more in a transverse row immediately behind mental frenum. ..... *mirabilis*.

No scales on nape; small uppermost ray of pectoral fin free for posterior one quarter to one half of its length; epipores large and distinct, 4 to 9 (usually 5 to 7) in opercular row number three (excluding secondary rows); usually 2, sometimes 3 epipores in a complete transverse row immediately behind mental frenum..... *seta*.

Gillichthys mirabilis

1864. *Gillichthys mirabilis* Cooper, J. G., Cal. Acad. Nat. Sci., Proc. 3: 109, Fig. 24 (mislabeled Fig. 18). Type: State Coll., No. 627, length 5¼ inches. Locale: San Diego Bay, California.

1889. *Gobius townsendi* Eigenmann, C. H., and R. S. Eigenmann, U. S. Nat. Mus., Proc. 11: 463. Type: USNM 40127, length 45 mm. Locale: San Diego Bay. (*G. townsendi* = *Gillichthys mirabilis* Cooper; Eigenmann, C. H., Zoe 1: 67, 1890).

1898. *Gillichthys detrusus* Gilbert, C. H., and N. B. Scofield, U. S. Nat. Mus., Proc. 20 (1131): 499, Pl. 38. Type: USNM 48127, length about 5 inches. Locale: Horsehoe Bend, Mouth of Colorado River. (*G. detrusus* = *G. mirabilis* Cooper; Starks, E. C., and E. L. Morris, Univ. Calif. Publ. Zool., 3 (11): 227, 1907).

1921. *Aprolepis barbarae* Hubbs, C. L., Mich. Univ. Mus. Zool., Occ. Pap. No. 99: 2. Type: UMMZ 55054, length 15 mm. Locale: Carpenteria, California. (*A. barbarae* = *G. mirabilis* Cooper; Hubbs, C. L., Mich. Univ. Mus. Zool., Occ. Pap. No. 169: 3, 1926).

Gilbert and Scofield (1898) described *G. detrusus* as a new species from the mouth of the Colorado River. The most important differences from *G. mirabilis* were said to be the wider and more depressed head, larger anal fin, and greater distance between dorsal fins. They recognized the close relationship between the two species.

Starks and Morris (1907) re-examined the types of *detrusus*. The head was narrower, not wider than that of *mirabilis* (in agreement with results in this paper), and the distance between dorsal fins in *detrusus* was slightly greater, as described by Gilbert and Scofield. The head depth and the size of the anal fin were not measured. Otherwise the specimens were nearly alike, so Starks and Morris concluded that *detrusus* and *mirabilis* were conspecific.

Hubbs (1921) disagreed with Starks and Morris, and regarded *detrusus* as a species distinct from *mirabilis*. However, from Hubbs' brief notes there is reason to believe that his Gulf material consisted of the then undescribed *Gillichthys seta* (Ginsburg). At my request, Loren P. Woods, Chicago Museum of Natural History, kindly re-examined the collection (CNHM 3339, 26 specimens), and found that Ginsburg had reidentified the fish as *Lepidogobius seta*. Using my key, Woods corroborated Ginsburg's identification.

In the present study, *detrusus* is regarded as a synonym of *mirabilis*. Much of the rationale for this statement is contained in a detailed study of the variation between populations of these two nominal species. The results, to be published soon, indicate a transition from one form to the other in the intervening populations. Furthermore, the rates of oxygen consumption characterising *mirabilis* and *detrusus* populations have been compared, and has been contrasted with that of *seta*; this work also will be published shortly. The findings support the contention that *detrusus* is the same species as *mirabilis*, and that *seta* clearly is a distinct species.

Description—Refer to Fig. 2. Only the range of fin counts is given here: Left Pectoral 18–23, Pelvic I, 5, First Dorsal IV–VIII, Second Dorsal I–III, 9–14, Anal I–II, 8–14, and Caudal 9 + 8, segmented rays of second dorsal plus anal, divided by pectoral and multiplied by 100 = 80 to 147 (termed the fin index).

From side, head bluntly rounded, dorsal profile more convex than ventral profile; viewed from above, snout broadly rounded before eyes, sides of head straight when operculae adducted. Eyes do not enter dorsal profile, 1.5 to 1.8 in soft interorbital. Posterior nares oblong or round in shape, just anterior to and clearly below center of anterior margin of eye. Gill-rakers usually 12 plus 3 (10 to 12 plus 2 to 4). Tip of tongue emarginate or notched. Maxilla reaches beyond preopercle sometimes to base of pectoral fin in large adults, range of length about same in males and females but mean greater in males, tip of maxilla slightly wider in males. Fold in ventral aspect of upper lip, but not developed into membranous flap.

About 80 to 100 irregular rows of scales (difficult to distinguish) from top of pectoral fin insertion to end of hypural plate, three to four almost complete vertical rows of scales on base of caudal fin rays. Margin of anterior-most scales extends from top of opercular opening, or just anterior to it, onto nape; margin variable, but arches towards posterior before reaching nape. Scales on nape in strip about one half eye diameter wide, extend forward distance equal to base of second dorsal fin. Axil usually scaled. Ventrally, anterior margin of scales reaches line between base of pectoral fin and base of pel-

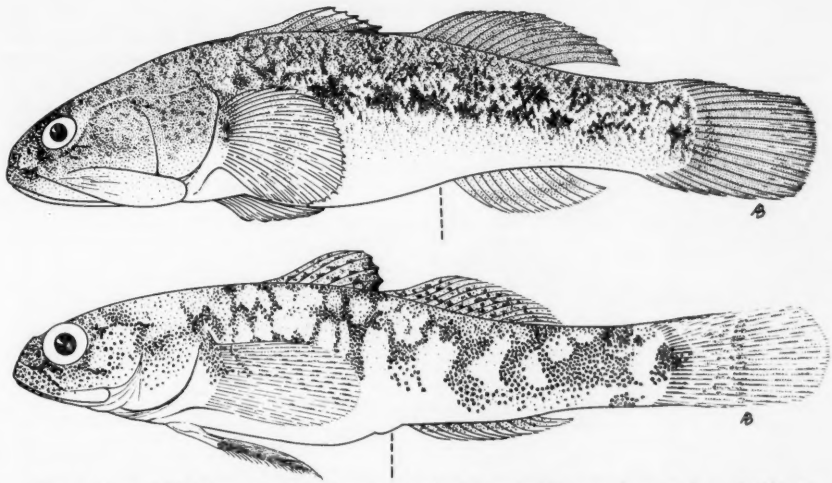

Fig. 2. Top: *Gillichthys mirabilis*, female, standard length 100 mm, from Goleta, California. Bottom: *G. mirabilis*, immature, standard length 29.0 mm, from Mulege, Baja California; eye slightly larger than normal.

vic fins, often anterior to base of pelvic fins for a distance up to one eye diameter, sometimes passing around and meeting in front of pelvic fin base. A small oblong patch without scales, about a third as long as the pelvic fin, immediately behind pelvic insertion.

Epipores small and crowded, sometimes difficult to separate, number per row increases with age (Fig. 1). Posterior terminations of cheek row and maxilla rows number one and two reach beyond cheek muscles to preopercle, anteriorly cheek row ends under eye between verticals through posterior margin of pupil to anterior margin of eye. Each maxilla row on crest of separate small fleshy fold over upper jaw, portions of rows sometimes hidden in folds in large adults. Two well developed rows of internarial epipores. Postorbital row number three present. A row of more than four epipores directly behind mental frenum. Median interorbital pore usually with raised rim, often closed to form papilla in adults, rarely double pores in subadults.

All pectoral fin rays bound by fin membrane. First dorsal fin higher than height of first ray of second dorsal fin which equals about two thirds length of pelvic fins. Dorsal profile of second dorsal fin slightly to well rounded. Distance between dorsal fins equal to one to two eye diameters. Origin of anal fin on vertical through third to fourth elements of second dorsal, anal profile gently rounded, sometimes rather straight. Caudal fin truncate, corners broadly rounded, usually symmetrical.

Color of adult in alcohol.—Body light brown, sometimes almost yellow, other times nearly black; sometimes five irregular black blotches on back down to middle of sides, a sixth blotch across occiput; a series of smaller blotches along horizontal septum alternate with larger blotches, occasionally form continuous line; black blotch on end of caudal peduncle often extends onto base of caudal fin rays. Head light brown, frequently black on snout, lip, upper one third of opercle, and under eyes; cheek sometimes with reticulations of darker brown; entire head sometimes black; throat and chin yellow to dusky, chin often dark brown or black. Pectoral fin dusky, lighter toward margin, without barring; upper half of base dark brown. Pelvic fins yellow, with or without scattered, contracted chromatophores. Both dorsal fins and anal fin usually heavily pigmented, almost black, dusky in pale specimens, margins white. Second dorsal fin rarely with traces of two to three horizontal stripes. Anal fin sometimes lighter proximally. Caudal fin dusky, often lighter at posterior margin.

Color of sub-adults in alcohol.—In subadult, standard length about 60 mm, body blotches always distinct. Posterior one third of first dorsal fin conspicuously black, rest of

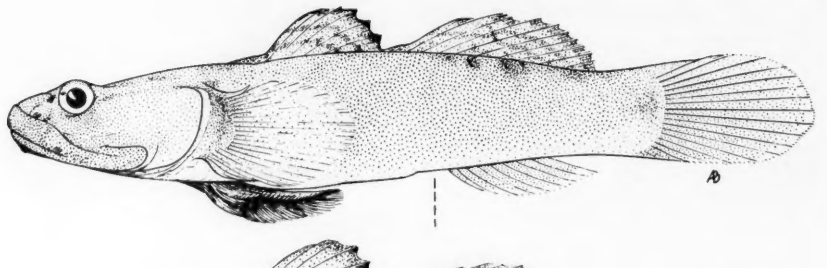

Fig. 3. Top: *Gillichthys seta*, female, standard length 46.2 mm, from San Felipe, Baja California. Bottom: *G. seta*, immature, standard length 32.1 mm, from Bahia Cholla, Sonora.

fin dusky with white margin. Second dorsal fin dusky with white margin, but with three to five horizontal stripes medially, variously developed and often indistinct. Caudal fin sometimes with thin, vertical bars. Otherwise colored as adults. (See Weisel, 1947, Fig. 3, for illustration of 32 mm juvenile).

Color in life.—Color mostly brown with some yellow, from melanophores and xanthophores, respectively. Salton Sea fish almost yellow, especially when taken inshore where yellow algal mat covers bottom. On Pacific Coast, body usually brown, sometimes bluish black. Colors which are white in preserved specimens are yellow in life, particularly on borders of dorsal and anal fins; yellow fin margin most intense on black specimens.

Variation.—The first step in the study of the morphological variation of *mirabilis* was to observe the divergence in three widely separated populations. Measurements taken on adult fish from Agiabampo (southeastern Gulf of California), Salton Sea, and San Francisco Bay, are summarized in Table 1. Those characters which differed most were then studied in several populations to determine the nature of the variation in relation to the distribution of the fish; the results of this study will appear in another article.

The Salton Sea population differs in many respects from the others (Table 1). All of the 13 measurements associated with the head are smaller, and five out of six measurements of body dimensions are greater. For the most part this is a reflection of the short head length.

Agiabampo fish differ from samples from San Francisco in several features. The average length of the Agiabampo fish, however, is less and the direction of the deviations is usually consistent with growth changes. Three conspicuous exceptions to this are the smaller head depth and width, the shorter length of the dorsal and anal fin bases, and the greater posterior height of the anal fin in the Agiabampo specimens. The lengths of the median fin bases reflect differences in the number of fin rays. This subject is one of the topics of a forthcoming article, as is head and fin size.

Distribution.—Gillichthys mirabilis occurs on the Pacific Coast of central California and Baja California, and in the Gulf of California. The range on the outer coast extends from Tomales Bay in the north (Roedel, 1953) to Bahia Magdalena in the south (Steindachner, 1876). The large numbers of this species in San Francisco Bay may constitute the northernmost permanent population. I trapped for this species at Tomales Bay and at Drake's Bay in the summer of 1955, but caught no *mirabilis*. Substantial samples of *mirabilis* obtained at Bahia Magdalena in 1955 indicate the population there is permanent.

In the Gulf of California *mirabilis* occurs north of Mulege on the west side, and south to Bahia Agiabampo on the east. Specimens

TABLE 1. MEASUREMENTS OF *Gillichthys mirabilis*

EXPRESSED AS AVERAGE PERCENT OF STANDARD LENGTH; RANGE IN PARENTHESES. Plus (+) means relative length of part increases with age; minus (−) indicates a decrease. Absence of such a mark signifies no obvious trend.

Locale	San Elijo Lagoon	San Francisco Bay		Agiabampo		Salton Sea	
Sex	Sub-adult	Female	Male	Female	Male	Female	Male
Number	5	6	5	8	2	13	6
Standard Length	59.7 (58.0–62.6)	101.0 (88.0–117.4)	93.2 (81.4–117.5)	83.5 (69.7–95.2)	83.5 (66.2–99.8)	102.9 (89.3–116.4)	93.9 (83.6–114.5)
Body Depth, Anterior	23.9 (22.9–24.8)	20.4 (18.6–21.7)	20.5 (19.6–21.5)	21.5 (19.8–23.0)	20.6 (19.6–21.6)	23.3 (21.9–24.9)	22.7 (21.3–24.5)
Body Depth, Posterior	18.7 (18.0–19.5)	17.6 (16.7–18.3)	18.0 (15.9–19.0)	18.1 (17.1–19.2)	17.3 (16.5–18.1)	19.6 (17.6–22.1)	19.4 (18.3–20.7)
Caudal Peduncle Length (−)	22.1 (20.5–23.7)	18.2 (15.7–19.2)	18.2 (17.2–20.7)	19.3 (17.5–20.5)	18.8 (17.4–20.2)	20.5 (17.9–21.6)	19.5 (18.5–20.4)
Caudal Peduncle Height	11.9 (11.4–12.3)	11.5 (10.8–12.4)	11.5 (9.7–12.8)	11.1 (10.7–11.5)	10.8 (10.2–11.3)	11.0 (10.5–11.8)	11.1 (10.7–11.3)
Snout to Vent (+)	58.5 (58.1–59.4)	63.2 (61.6–65.5)	62.9 (60.2–66.6)	62.3 (59.7–64.9)	62.7 (62.4–62.9)	61.0 (59.3–63.8)	61.3 (58.4–62.9)
Snout to Pelvic Fin (+)	31.2 (30.0–31.9)	33.8 (31.7–35.4)	34.0 (30.7–36.3)	31.4 (28.9–33.1)	32.5 (31.7–33.2)	32.6 (29.7–36.6)	31.0 (28.7–33.7)
Predorsal Distance	42.0 (41.5–42.4)	42.7 (41.3–44.6)	43.1 (40.5–44.7)	42.8 (41.8–44.3)	42.9 (42.9)	40.7 (39.2–42.7)	41.6 (40.4–44.3)
Head Length (+)	30.9 (30.1–31.1)	33.7 (32.3–34.0)	35.0 (32.1–37.3)	33.1 (31.5–34.6)	33.1 (32.5–33.5)	30.5 (28.9–33.0)	31.1 (29.7–32.3)
Head Depth (+)	16.0 (15.2–17.2)	17.9 (15.6–19.9)	17.9 (16.4–19.4)	15.6 (14.1–17.3)	15.3 (15.2–15.3)	14.3 (13.3–16.1)	14.0 (12.8–15.2)
Head Width (+)	20.3 (19.0–21.2)	24.7 (22.7–25.6)	23.5 (22.0–25.4)	20.9 (18.1–22.8)	19.8 (18.5–21.1)	18.9 (16.8–21.2)	18.9 (18.1–19.5)
Jaw Length (+)	20.9 (20.5–21.6)	28.6 (26.8–30.8)	30.4 (25.4–35.2)	26.3 (23.7–29.6)	28.2 (24.3–32.2)	25.2 (21.3–31.3)	26.4 (24.4–29.1)
Maxilla Tip, Height (+)	3.1 (2.6–3.5)	4.3 (3.8–4.9)	5.0 (4.1–6.4)	3.8 (3.1–4.3)	4.6 (4.2–5.0)	3.3 (3.0–4.0)	4.1 (3.1–4.4)
Orbit Length (−)	5.1 (4.9–5.3)	4.9 (4.6–5.3)	5.1 (4.9–5.5)	5.3 (4.4–5.7)	5.3 (4.6–6.0)	4.7 (3.9–5.1)	5.1 (4.8–5.3)
Fleshy Interorbital (+)	6.5 (6.0–7.2)	7.2 (6.5–7.6)	7.3 (7.2–7.7)	6.6 (5.9–7.3)	6.9 (6.5–7.2)	5.9 (4.9–7.2)	6.4 (5.6–7.9)
Snout Length (+)	7.8 (7.4–8.0)	9.4 (9.2–10.0)	8.9 (7.1–10.0)	8.3 (7.3–9.4)	8.4 (8.3–8.5)	7.8 (7.3–8.6)	8.0 (7.3–8.8)
Snout Width (+)	8.1 (6.0–9.0)	9.6 (8.7–10.2)	9.2 (7.9–9.9)	8.7 (7.9–9.0)	8.8 (8.6–8.9)	8.6 (8.0–9.2)	8.6 (7.8–9.2)
Cheek Length (+)	11.8 (11.3–12.6)	12.6 (11.8–13.5)	13.0 (11.7–14.1)	12.0 (11.5–13.0)	12.6 (11.9–13.2)	11.6 (11.0–12.7)	12.0 (11.0–13.3)
Caudal Fin Length	20.7 (19.0–21.6)	19.6 (19.0–21.0)	20.3 (18.9–21.4)	20.9 (19.7–22.2)	20.9 (20.5–21.3)	19.7 (18.9–20.7)	20.0 (17.8–21.2)
Pectoral Fin Length (−)	22.2 (21.3–23.2)	19.7 (18.4–21.3)	20.4 (17.9–22.4)	20.8 (18.1–21.8)	20.0 (19.5–20.4)	19.4 (17.8–21.1)	19.8 (17.8–22.2)
Pelvic Fin Length (−)	17.0 (16.6–17.8)	13.9 (11.6–16.3)	14.1 (12.3–14.8)	15.4 (14.4–16.5)	16.0 (15.3–16.6)	14.8 (12.9–15.6)	14.7 (13.7–15.7)
Anal Fin Height	8.6 (8.4–8.9)	8.6 (7.7–9.2)	9.1 (8.6–9.9)	10.1 (9.3–11.0)	11.5 (11.2–11.7)	8.7 (7.6–9.7)	9.2 (8.5–10.4)
Anal Fin Base	17.3 (16.3–18.4)	15.8 (14.9–17.2)	17.0 (15.9–17.9)	15.2 (14.3–16.1)	15.6 (15.1–16.0)	17.0 (15.4–18.6)	17.7 (16.8–18.5)
Second Dorsal Fin Base	21.1 (20.8–21.4)	21.9 (21.0–22.6)	22.7 (21.4–24.0)	20.5 (20.1–21.6)	20.4 (19.6–21.2)	23.0 (21.7–23.9)	23.5 (21.1–25.9)
Length of Scalation on Nape	—	17.6 (14.6–19.3)	18.3 (14.7–20.4)	17.3 (15.2–18.7)	19.6 (19.5–19.6)	15.2 (12.7–18.9)	16.3 (13.2–18.3)
Papilla Width	—	2.9 (2.5–4.1)	1.9 (1.6–2.5)	—	—	3.5 (3.0–4.1)	2.2 (1.8–2.5)
Papilla Length	—	2.6 (2.2–3.2)	2.2 (1.6–3.1)	—	—	2.0 (1.6–2.4)	1.7 (1.3–2.2)

also have been collected at "El Marino" which is a slough 25 kilometers north of San Felipe, at Bahia Cholla, at Bahia San Jorge, in the Guaymas region at Puerto San Carlos, Estero Soldado, and Playa Bocochibampo, and at Yavaros. No *mirabilis* have been taken at Mazatlan, south of Agiabampo, or at La Paz, south of Mulege, though collections have

been made at both places. The collections south of Mulege, however, have been neither numerous nor intensive enough to prove *mirabilis* does not occur in that region.

A population of *mirabilis* has been established in the Salton Sea. About 500 fish were released in the Sea in 1930 by the California Department of Fish and Game. The stock was obtained from San Diego Bay. It has been suggested (C. L. Hubbs, personal communication) that some *mirabilis* from the Gulf of California may have been introduced accidentally into the Salton Sea by live-bait dealers. The present stock most likely is derived from the plant from San Diego, however.

Ecology.—The typical habitat of *mirabilis* is shallow back-water areas with soft, muddy bottom. Less often it dwells in lagoons found at mouths of dry rivers. The back-water habitats are characteristically tidal flats in the inland portions of bays. Deeply incised channels with steep banks meander through these flats. At high tide the area is covered by a thin sheet of water, but at low tide only pools remain in some of the channels. When the tide is out the gobies live in these small pools, or above the water level in burrows in the bank (Lockington, 1877, and personal observations). When out of water, *mirabilis* employs aerial respiration. In the lagoons there is no tidal exchange during much of the year.

In the Salton Sea, *mirabilis* is most abundant near the shore and in pools along the shore. Individuals congregate in places sheltered from wave action and near cover such as rock or brush piles. Several specimens were trapped at depths up to seven meters, and a few males were taken at a depth of twelve meters. The ecological valence of *mirabilis* in the Salton Sea is far greater than that of naturally occurring populations. (These observations were made before the large, piscivorous fishes of the genus *Cynoscion* became abundant in the Salton Sea).

Gillichthys mirabilis is confined to waters of moderate to high salinity. Hypersaline conditions are common where these fish occur, but the fish usually are absent where the water is at times fresh or only slightly brackish. Lars H. Carpelan (personal communication) observed *mirabilis* in water with a salt content of 82.5‰ in a pond at "El Marino." Carpelan (1957) also reported the occurrence of *mirabilis* in the highly saline Alviso Ponds of San Francisco Bay. I have taken this fish from shore pools of the Salton Sea where the salinity was 62‰. Fish kept in fresh water at the laboratory died within one to two weeks, but this may have been due to the quality of the tap water.

The spermatozoa of *mirabilis* seem best adapted to water with a salinity close to that of the ocean (approximately 35‰). The activation time is shortest at about 35‰, although the spermatozoa are motile for the longest period of time at roughly 8‰ (Weisel, 1948). Motility is maintained even in water with a salinity near 70‰, but the spermatozoa are immotile when the salt content of the water is below approximately 6‰ (Weisel, 1948).

Gillichthys seta

1938. *Lepidogobius seta* Ginsburg, I., Allan Hancock Pac. Exped., 2(7):119. Type: USNM (no number), length 58 mm. Locale: Angel de la Guarda Island, Gulf of California.

1908. *Gillichthys mirabilis* not of Cooper. Evermann, B. W., Wash. Biol. Soc., Proc. 21:29. Locale: Bahia de San Felipe, Gulf of California.

1921. *Gillichthys detrusus* not of Gilbert and Scofield. Hubbs, C. L., Mich. Univ. Mus. Zool., Occ. Pap. (99):4. Locale: Bahia de San Felipe, Gulf of California.

1947. *Gillichthys seta* (Ginsburg). Weisel, G. F., Copeia, 1947(2):77. New combination.

Description.—Refer to Fig. 3. Fin counts based on 30 specimens (except for caudal and pelvic fin), range is followed in parentheses by the mean, ± one standard deviation. Left pectoral 20–23 (20.7 ± 0.68), spiny dorsal V–VI (5.97 ± 0.17), second dorsal I, 9–10 (9.47 ± 0.58), anal I, 7–9 (8.00 ± 0.72), pelvic I, 5, caudal 9 + 8; segmented rays of second dorsal plus anal, divided by pectoral and multiplied by 100 = 74–90 (82.4) (fin index).

Head, viewed from side, forms long isosceles triangle with apex at upper lip, from above, snout sharply rounded. Eyes make slight break in dorsal profile of head, 1 to 1.4 in soft interorbital. Posterior nares just anterior to inferior half of eye, "tear-drop" in shape, sharp end points toward superior margin of eye. Gill-rakers usually 12 plus 4 (10 to 12 plus 3 to 4). Tip of tongue emarginate or rounded, not notched. Maxilla reaches preopercle in adults, seldom beyond, longer and with wider tip in males. A membranous flap between teeth and lip of upper jaw, similar but smaller flap in lower jaw.

About 60 to 70 uneven rows of cycloid

scales from top of pectoral fin insertion to end of hypural plate, anteriormost scale about one eye pupil diameter above top of pectoral fin insertion, two to four almost complete vertical rows of scales on base of fin rays. The following areas naked: head, nape, throat, strip along anterior two thirds of first dorsal fin base about as wide as anterior nares tube is long, under pelvic fins, and vertical strip in axil of pectoral fin about one half to three fourths eye diameter wide.

Epipores distinct and well spaced, rows of epipores less extensive than in *G. mirabilis* (Fig. 1). Posterior terminations of maxilla rows reach to swelling of cheek muscles, posterior end of maxilla row number two curves towards that of cheek row. Each maxilla row on crest of separate fleshy fold, sometimes partially in groove of fold. Cheek row reduced, anterior end usually does not reach opposite posterior margin of eye, rarely opposite posterior margin of pupil. Internarial rows reduced to one or two epipores each. Only one to two epipores in postorbital row number three, postorbital row number two reduced anteriorly. Usually not more than two to three epipores immediately behind mental frenum. Median interorbital pore open, rim usually not raised.

Tiny, uppermost ray of pectoral fin about one quarter to one half free. Second dorsal fin higher than first, anterior height equals length of pelvic fins, profile gently rounded. Distance between dorsal fins equal to about one eye diameter. Origin of anal fin on vertical through base of second to third element of second dorsal fin. Anal fin sometimes with small posterior lobe, otherwise profile gently rounded. Caudal fin truncate, broadly rounded, upper rays usually longer than lower, sometimes equal.

Color in Alcohol.—Sides of body light brown, lighter towards belly which is yellow, 4 to 5 patches of darker brown on sides of body alternate with 5 to 6 patches of white, 2 dark patches on nape, entire body, however, may be uniformly light brown. Top and sides of head and lips brown, darker beneath eyes and sometimes darker on snout and between eyes, occasionally vermiculations of darker brown beneath eye and on lips, ventral side of head yellow-brown with scattered melanophores on chin. Pectoral fin dusky from scattered, punctiulate melanophores which sometimes form thin, irregular, vertical bars; color lighter at margin of fin, more pigment on upper half of fin base than on lower. Pelvic fins yellow, occasionally few contracted melanophores present. First dorsal fin with 3 to 4 irregular stripes at right angles to spines. During breeding fin may be entirely black, or dusky with black patch in posterior half of fin. Second dorsal fin with 4 to 6 dark stripes almost parallel to back, stripe at margin usually widest but sometimes not distinct, 2 basal rows usually restricted to anterior half of fin and not distinct, 3 intervening stripes well defined, entire fin sometimes black or dusky with white margin. Anal fin uniformly dusky except for clear margin; in reproductive season fin either black with white margin, or dusky with black band just under white margin. Caudal fin dusky, lighter toward margin.

Color in life.—Basic colors brown with some yellow from melanophores and xanthophores, relative intensity dependent on amount of light and color of background. In general, white colors in preserved specimens were yellow in life, especially on margins of median fins.

Variation.—The morphology of *seta* from exposed rocky shores differs somewhat from those from protected places inside of bay mouths. This conclusion is based on a comparison of females from an unprotected rocky shore at San Felipe and from a rocky pool in Bahia San Jorge (Table 2). It should be made clear that genetical divergence is not ruled out. Obvious differences were apparent in six of the measurements made, and these were studied in greater detail.

The fish from the bay have the shorter cheeks, more slender caudal peduncles, higher anal fins, and longer pectoral and pelvic fins (differences are significant, Table 3). The caudal fins are nearly equal in length, however.

Although the means of five out of six measurements are significantly different, most of their variances are not (Table 3). Only the variances of the pectoral fin length are different. The variance is greater in the sample from the exposed shore.

Generally speaking, the fish from the bay are more slender and have longer fins than those from open rocky shores. In addition, most of the measurements associated with the head are smaller in the *G. seta* from Bahia San Jorge.

The specimens of *seta* from Bahia San Jorge also have significantly more epipores in opercular row number three than those from San Felipe (Table 3). The mean number is 6.73 ± 1.61 (4–12) for the fish from the bay, and 5.93 ± 1.11 (4–8) for those from the exposed

TABLE 2. MEASUREMENTS OF *Gillichthys seta*

Expressed as average percent of standard length; range in parentheses.

Locale	Bahia San Jorge	San Felipe	
Sex	Female	Female	Male
Number	5	5	5
Standard Length	57.9 (57.1–58.6)	60.6 (57.6–65.8)	59.0 (56.4–61.0)
Body Depth, Anterior	19.3 (18.2–19.8)	19.7 (18.5–20.7)	19.3 (17.2–20.5)
Body Depth, Posterior	17.0 (16.5–17.5)	18.0 (17.4–19.6)	17.3 (16.1–18.9)
Caudal Peduncle Length	21.5 (20.7–22.0)	22.2 (21.6–22.9)	22.0 (21.9–22.8)
*Caudal Peduncle Height	9.77 ± 0.55 (8.9–10.3)	11.75 ± 0.43 (11.1–12.0)	11.4 (10.5–11.8)
Snout to Vent	60.4 (58.5–63.0)	59.9 (58.3–60.8)	61.9 (60.4–64.4)
Snout to Pelvic Fin	29.5 (28.1–30.6)	29.6 (29.1–30.4)	32.5 (31.3–33.2)
Predorsal Distance	40.3 (38.9–41.9)	40.7 (39.1–41.9)	42.2 (40.8–43.1)
Head Length	29.8 (28.7–30.6)	29.9 (29.5–30.4)	32.3 (31.5–32.9)
Head Depth	11.9 (10.8–13.0)	12.9 (12.2–13.2)	13.0 (12.5–13.7)
Head Width	18.4 (18.1–19.3)	19.9 (19.6–20.2)	19.8 (19.1–20.8)
Jaw Length	20.3 (19.8–20.7)	20.8 (20.0–22.2)	25.0 (24.1–25.6)
Maxilla Tip, Height	3.0 (2.4–3.3)	2.8 (2.6–3.2)	3.9 (3.4–4.2)
Orbit Length	5.4 (5.1–5.6)	5.6 (5.1–5.8)	5.7 (5.3–5.9)
Fleshy Interorbital	5.7 (5.2–6.0)	5.4 (4.4–6.5)	6.1 (4.9–6.5)
Snout Length	8.7 (8.7–8.8)	8.9 (8.2–9.9)	9.3 (8.9–9.7)
Snout Width	8.0 (7.7–8.4)	8.9 (8.7–9.1)	9.6 (9.3–9.9)
*Cheek Length	10.71 ± 0.33 (9.6–11.1)	11.24 ± 0.49 (10.5–11.8)	12.9 (12.4–13.6)
*Caudal Fin Length	20.98 ± 1.28 (18.6–23.3)	20.76 ± 0.99 (19.5–22.7)	20.8 (20.3–22.0)
*Pectoral Fin Length	22.56 ± 0.89 (20.7 – 24.4)	20.74 ± 1.44 (18.7–23.0)	20.8 (18.4–22.5)
*Pelvic Fin Length	16.27 ± 0.78 (14.9–18.0)	15.51 ± 1.00 (13.1–17.3)	16.2 (15.2–17.2)
*Anal Fin Height	10.77 ± 0.42 (9.8–11.6)	10.16 ± 0.61 (9.0–10.9)	10.6 (9.8–11.5)
Anal Fin Base	14.6 (13.9–16.9)	14.6 (13.7–15.1)	14.4 (13.9–15.6)
Second Dorsal Fin Base	21.0 (20.1–22.4)	20.0 (19.4–21.0)	20.0 (19.5–21.7)
Papilla Width	2.0 (1.8–2.3)	2.0 (1.6–2.4)	1.4 (1.2–1.6)
Papilla Length	2.7 (2.4–3.2)	1.7 (1.1–2.3)	1.8 (1.6–2.0)

* Parameters based on a sample of 20; mean followed by ± one standard deviation; for Bahia San Jorge mean Standard Length is 57.2 (52.4–61.9) and for San Felipe 58.0 (53.2–65.8).

TABLE 3. STATISTICAL TESTS FOR *Gillichthys seta* FROM SAN FELIPE AND BAHIA SAN JORGE

	Hypothesis:							
	Equal Means				Equal Variances			
	t	d.f.	$t_{.975}$	Decision	F	d.f.	$F_{.975}$	Decision
Cheek	4.00	38	2.02	Reject	2.22	19, 19	2.54	Accept
Caudal Peduncle Height	12.69	38	2.02	Reject	1.67	19, 19	2.54	Accept
Anal Fin Height	3.39	38	2.02	Reject	1.36	19, 19	2.54	Accept
Caudal Fin Length	0.61	38	2.02	Accept	1.67	19, 19	2.54	Accept
Pectoral Fin Length	4.80	38	2.02	Reject	2.56	19, 19	2.54	Reject
Pelvic Fin Length	2.66	38	2.02	Reject	1.64	19, 19	2.54	Accept
Epipores (Op. 3)	2.24	58	2.00	Reject	2.11	29, 29	2.10	Reject

Key: t = t value; F = F ratio; d.f. = degrees of freedom; $_{.975}$ = 5% critical value.

situation (N = 30 in each sample). The variances are significantly different, but only by a small margin (Table 3).

The increase in number of epipores in the bay sample sometimes results in the formation of one or two short secondary rows just above the posterior termination of the lower opercular row. The maximum count of 12 consists of one complete opercular row of nine with two, then one, epipores directly above it. The epipores of the other rows were not counted. It seems reasonable to assume that on the fish from the bay the epipores in the other rows increase in number commensurate with the increase in opercular row number three.

Distribution.—Gallichthys seta is found only in the northern half of the Gulf of California. The southern record is based on one specimen from Punta San Francisquito. Other known localities are at Punta Peñasco and Puerto Libertad on the east coast; at Bahia San Felipe, Punta Diggs, Puertecitos, and Bahia Los Angeles on the west coast; and on the islands at Freshwater Bay, Isla Tiburon, and at Puerto Refugio, Isla Angel de la Guarda.

Ecology.—Gillichthys seta is geographically sympatric with *G. mirabilis* but ecologically separated. Juveniles of the two species, however, sometimes are found together in ecological transition areas during the spring. *Gillichthys seta* lives in the highest intertidal region of rocky shores in small pools or in tidal streams which course through cobble and sand. In the lower zones another goby, *Garmannia chiquita* (Jenkins and Evermann) is the common species.

ONTOGENY OF THE CEPHALIC SENSORY CANAL SYSTEM

No canals exist in nektonic post-larvae. At the initiation of the benthonic color phase, independent of the length of the fish, a fold appears above each eye and closes over to form the supraorbital canal; three epipores are enclosed in the canal. A slitlike opening persists briefly in the roof of the canal. This opening widens mesially and moves towards the midline forming a canal in its path. Before meeting its counterpart, the opening rounds up into a pore. These two interorbital pores meet to form a single opening with a continuous interorbital canal beneath it. Just before the interorbital pores meet, a short horizontal fold appears immediately posterior to the postorbital pore. This fold forms a tube which encloses the anterior branch of the postorbital number one row of epipores. With growth, the canal elongates posteriorly along the row of epipores and stops above the preopercle. This stage of development is attained usually by the time the juvenile fish reach about 20 to 30 mm standard length. In the largest adults the interorbital pore is often covered over with epidermis, forming a small papilla. Depending on the preservation, this papilla may be difficult to locate.

Gillichthys seta AND *mirabilis* AT COMPARABLE SIZES

The morphology of adult *seta* is remarkably similar to that of sub-adult *mirabilis* of the same length. The greatest differences between *seta* from the Gulf and sub-adult *mirabilis* from the Pacific Coast (San Elijo Lagoon, near San Diego, California), are the

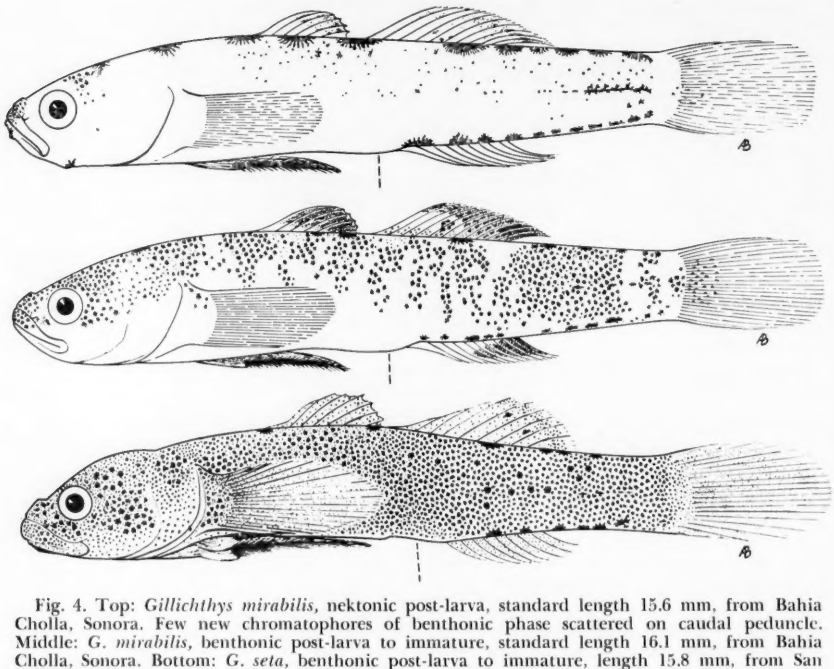

Fig. 4. Top: *Gillichthys mirabilis*, nektonic post-larva, standard length 15.6 mm, from Bahia Cholla, Sonora. Few new chromatophores of benthonic phase scattered on caudal peduncle. Middle: *G. mirabilis*, benthonic post-larva to immature, standard length 16.1 mm, from Bahia Cholla, Sonora. Bottom: *G. seta*, benthonic post-larva to immature, length 15.8 mm, from San Felipe, Baja California.

shallower head, narrower fleshy interorbital, longer snout, and higher anal fin of *seta* (compare Table 2 with column one of Table 1). Some of the differences are magnified by the unusually robust condition of the *mirabilis* from San Elijo Lagoon. These differences are not always so apparent in comparisons between other samples, especially in those which involve sub-adult *mirabilis* from the Gulf. No matter which populations are considered, the body proportions of sub-adult *mirabilis* resemble those of *seta* of the same size, with exceptions noted above, more than those of their own adults.

Post-Larvae of *Gillichthys seta* and *mirabilis*

The nektonic post-larva of *mirabilis*, in its terminal phase, is nearly transparent. A series of large black chromatophores lines the back and also the ventral surface posterior to the vent (Fig. 4; and Weisel, 1947, Fig. 2). A chain of smaller chromatophores makes a thin horizontal line in the middle of the caudal peduncle. In preserved material the distal half of the caudal peduncle is markedly more transparent than the rest of the body.

The post-larva of *mirabilis* in the early benthonic stage has many small chromatophores over the body, but the large chromatophores which characterize the nektonic phase are still evident (Fig. 4, and Eigenmann, 1890, Fig. 15). The transition between nektonic and benthonic phases occurs in post-larvae between about 9 to 16 mm standard length. Small pigmented fish have been found together with unpigmented specimens nearly twice their length. The color pattern of the benthonic post-larva foreshadows that of the sub-adult.

The color pattern of the post-larva of *seta* (Fig. 4; immature specimen of *seta* still showing much of post-larval pattern) is similar to that of the post-larva of *mirabilis*. They differ mostly in the number of large chromatophores on the body. On the back, from the first dorsal fin to the caudal fin, there are six chromatophores in *seta* and five in *mirabilis*; the number along the anal fin base and the bottom of the caudal peduncle is five to six in *seta* and nine to ten in *mirabilis*.

The post-larva of *seta*, as compared to that of *mirabilis*, evidently transforms from the nektonic to the benthonic color phase at a

smaller size. Two of the smallest specimens of *seta* collected, 12 mm in standard length, still had the typical nektonic color pattern. All other specimens, 12 to 20 mm in length from several collections, were well pigmented or clearly in the late stages of transformation. The color pattern of the benthonic post-larva is essentially the same as that of the adult.

Relationship between *Gillichthys mirabilis* and *seta*

Gillichthys seta probably evolved from the widely distributed *mirabilis* by adapting to a unique habitat in the upper Gulf region. The high intertidal zone of the few rocky shores in that region presents a rigorous and marginal habitat occupied by a few organisms. The development of individuals in marginal habitats would be retarded. Small size, as compared to that of adult *mirabilis*, would be advantageous to fish living in the shallow pools and crevices of those rocky shores. In this instance natural selection should favor slowly developing individuals, and thus result in the evolution of a paedomorphic form. This appears to be the case with *seta*.

Gillichthys seta could be derived from *mirabilis* by selectively altering developmental rates for various body parts (heterochrony). In the following respects *seta* is more "youthful," or retarded, than *mirabilis*: small size at maturity and small maximum length; scalation less complete; epipores large; interorbital pore never closed and its rim not raised, or only slightly so; posterior nares tear-drop in shape; post-orbital process of sphenotic small; and coloration similar to sub-adult of *mirabilis*, especially on the fins. On the other hand, *seta* is more "adult" than *mirabilis* in head shape when equal sizes are compared. The head of *seta* is more depressed, and pointed to a degree approached, but not equalled even by large *mirabilis*. Many of the body proportions are alike when fish of the same sizes are compared. Plots of head length, jaw length, eye diameter, and anal fin heights, versus standard lengths, are nearly the same, especially when *seta* is contrasted with *mirabilis* from the Gulf. In its distinctive features, though, *seta* could be considered to be a peadomorphic form of *mirabilis*.

Gillichthys seta is more like *mirabilis* from the Gulf of California than *mirabilis* from the Pacific Coast. Some characters in *seta* are an extension of trends seen in *mirabilis* in the Gulf. The mean of the fin index is lowest in *mirabilis* from the Gulf, especially in the northern region (about 95), and is still lower in *seta* (about 82). The head is more depressed in *mirabilis* from the Gulf, and even more so in *seta*. Likewise, in the Gulf both species have higher fins and a comparable number of scales on the body. In degree of ventral scalation, however, *seta* differs more from *mirabilis* from the Gulf than from those of the outer coast. Also, where *seta* and *mirabilis* are sympatric, they diverge in the degree of separation between dorsal fins.

Comment

The gobies constitute a widely distributed group of fishes, chiefly tropical, consisting of an enormous number of species. The intragroup arrangement is not well understood. Apparently they are capable of evolving rapidly and of radiating into unoccupied niches when the opportunity presents itself. One might expect, therefore, to encounter in this group many instances of parallel, or convergent, evolution.

In most instances the general structural organization of these species unfortunately remains relatively unchanged. On the other hand, the gross morphology of a given species frequently is altered by preservation to a greater extent than is customary, not to mention environmental effects. Generally speaking, they seem morphologically rather plastic. This is especially true of the large-mouthed, soft-bodied forms.

It is not surprising then that there is a certain appeal about the possibility of classifying the gobies on the basis of discrete patterns of epipores and sensory canals found on their heads. Though not always stated, Ginsburg evidently bases much of his arrangement of the gobies on this character.

The system of sensory canals and epipores may be highly adaptive and consequently labile. If so, care must be exercised in employing it as an indicator of wide relationships. As shown in this paper, the development of sensory canals is clearly associated with the change from nektonic to benthonic habits, irrespective of the actual size of the post-larva. Observations are needed on the habits of adult gobies in relation to the arrangement of the epipores and canals.

If the sensory canals are to be used as a discrete variable in the determination of relationships, it must be decided first at what stage, or combination of stages, of development the system should be regarded as diagnostic. For instance, most adults of *Gillichthys mirabilis* have a median interorbital

pore. Yet the extremely large specimens commonly lack the median pore altogether.

Evidently development of the canal and epipore system follows a program of predictable elaboration even long after sexual maturity has been reached. Thus one might argue that the facies of the system merely reflects how long it has been allowed to develop. It might be predicted that in small species of gobies, just as in small individuals of a given species, the sensory canals would be missing. This condition of reduced epipores and absence of sensory canals in the post-larvae of *Gillichthys*, for instance, resembles the condition found in many small gobies with little, steep mouths, and big eyes (post-larval condition) such as *Lythrypnus* and *Gobiopterus*. Most of the larger species probably have more or less completely developed canal and epipore systems. Species of gobies of intermediate sizes might be expected to reveal systems of more variable development. This would depend upon the rate of development of the system relative to the overall rate of growth of the species in question. Changes in the relationship between elaboration of epipores and of sensory canals doubtless exist.

The nature of the environment may be another though less disturbing factor. To illustrate, secondary rows of epipores in *G. seta* may appear, or fail to appear, apparently depending on conditions of the environment.

Proper utilization of the epipore and sensory canal system should include a consideration of other characters which are both obviously sensitive to changes in developmental rates, and are determined largely after the larval period has elapsed. These would include such characters as degree and kind of scalation, size and angle of the mouth, eye size, and pigmentation. Careful studies of the ontogeny of the epipores and sensory canals from widely unrelated gobies would seem to be a necessary prelude to their use as a taxonomic tool in classification above the generic level.

Summary

The genus *Gillichthys* is restricted to the nominal species *mirabilis* and *seta*, and *detrusus* is placed in the synonomy of *mirabilis*. The genus and both species are redescribed, based on a large series of collections, and both are illustrated at various stages of development. The cephalic pores and epipores also are figured and described. The post-larvae of each species are discussed, and pertinent differences in color patterns are pointed out. A key to the species is given.

Gillichthys mirabilis is known from coastal sloughs in central California south to Bahia Magdalena, and in the Gulf of California south to Mulege on the west coast, and south to Bahia Agiabampo on the east coast. It is also common in the Salton Sea, where it was introduced by the California Department of Fish and Game. *Gillichthys seta* is confined to rocky areas of the high intertidal zone of the open coasts in the northern part of the Gulf of California.

Considerable variation is evident in comparisons of widely separated populations of *mirabilis*. Differences are apparent, too, between specimens of *seta* from exposed and from protected sites, the latter being more slender and having longer fins, as well as more numerous cephalic epipores.

At maturity, *seta* is roughly half the size of *mirabilis*. When compared at the same lengths, the two species appear strikingly alike. The immediately perceptible differences are the flatter heads and higher median fins in specimens of *seta*.

Gillichthys seta probably was derived from the widely distributed species *mirabilis* because it is restricted to a unique habitat, perhaps ephemeral, found only in the northern region of the Gulf of California. The peculiarities of this environment, it would seem, favor small individuals. Size reduction can be achieved by slowing developmental rate. Apparently this has happened, and resulted in the evolution of a paedomorphic form of *mirabilis*, the species *seta*.

The system of cephalic sensory canals and epipores manifests a period of active elaboration coincident with the transition of the post-larva from a nektonic to a benthonic way of life. The system continues to undergo changes, even after maturity has been reached. Classifications of gobies based on these characters must take into consideration the profound changes associated with ontogeny, as well as the relative size achieved by the adult, way of life, and environmental modification.

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Results of the Amami Islands Expedition No. 4 on a New Sparoid Fish, *Gymnocranius japonicus* with Special Reference to its Taxonomic Status[1]

MASATO AKAZAKI

THE so-called sparoid fishes, embracing the Sparidae, Denticidae, Lethrinidae and others, chiefly inhabit waters of the littoral zone in temperate and tropical regions. In this group there is a subgroup having 10 spines and 10 soft rays (rarely 9) in the dorsal fin and scales on the cheek. This subgroup was designated by Smith (1941) as the family Pentapodidae represented by 4 genera, *Pentapodus, Monotaxis, Gymnocranius,* and *Gnathodentex*. The family has since been accepted by Munro (1955), Matsubara (1955), and Kamohara (1957).

During study of the sparoid fishes, the author has examined both the external and internal characteristics of pentapodid fishes collected from the seas around the Amami Islands and adjacent regions. The results obtained suggested the following conclusions (Akazaki 1959): 1) *Pentapodus* is different from the other 3 genera of this group, but is rather closely related to *Nemipterus* and *Scolopsis*. 2) The 3 remaining genera, *Gymnocranius, Gnathodentex,* and *Monotaxis* are so similar to one another that they are retained in the same group.

In this paper, the author places these 3 genera into a newly erected subfamily Monotaxinae of the Lethrinidae, with *Monotaxis* Bennett, the oldest among them as its type genus. Further, a sparoid fish recently collected from the waters of the Amami Islands is found to be closely related to the hitherto known species of *Gymnocranius,* but is distinguishable from them at least in having molar teeth on both jaws. Therefore, it is described herein as a new species of *Gymnocranius.*

Counts and measurements of the bodily parts were made according to standard practice as outlined by Matsubara (1955). In the osteological examination the skeletal elements were stained with alizarin red and cleared with potassium hydroxide and glycerol.

The author expresses his deep gratitude to Prof. K. Matsubara under whose direction this study was carried out. Grateful acknowledgment is made to Dr. R. M. Bailey of The University of Michigan and Dr. J. C. Briggs of The University of British Columbia for their critical reading of the manuscript and suggestions, and also to Dr. A. Ochiai of Kyoto University for his invaluable advice. The author also wishes to acknowledge generous financial assistance from the Nankai Electric Railway Company.

SUBFAMILY *Monotaxinae nov.*

Body oblong, compressed and elevated. Eye generally large. Suborbital region very wide.

[1] Contribution from the Marine Biological Institute of Kyoto University, No. 6.

Interorbital space broad and moderately convex. Mouth slightly oblique and relatively small. Nostrils 2 on each side, closely set, the anterior one elliptical in shape, furnished with a small flap. Jaws with 2–3 paired canines anteriorly, a single series of molar or molar-like conical teeth laterally. Vomer, palatine, and tongue edentate. Lips narrow anteriorly, becoming wider posteriorly; the posterior part more than twice as wide as anterior part.

Gill rakers on first arch 3–5 + 5–6 = 8–11, short and tubercular, the inner surface armed with a patch of villiform spinules. Branchiostegal rays 6.

Dorsal fin single, composed of 10 spines and 9 or (usually) 10 soft rays. Anal with 3 spines and 9 or (usually) 10 soft rays. Pectoral fin with 14–15 soft rays (usually 14). Caudal forked or lunate, the lobes not filamentous, but rather blunt.

Scales moderately large and feebly ctenoid. Nape and interorbital region naked, preopercular flange scaleless. Posterior part of interopercle scaly. Dorsal and anal rays with low scaly sheath. An elongate triangular scale on base of pelvic fin. Pored scales on lateral line 43–50 (70 in one species).

Premaxillary lamina as long as or shorter than the pedicel, without supra-median process on the upper margin. Opisthotic bone invisible. Epiotics not forked posteriorly. Two processes developed on lower base of parasphenoid. Preorbital wider than long, closely resembles first suborbital both in size and shape. Suborbital shelf small and boot-like in shape. Imperfect interneural spines 3, top of the first one heart-shaped. First and second interneural spines placed between second and third neural spines. Vertebrae 10 + 14 = 24. Upper part of urohyal bifoliate.

Key to Genera of Monotaxinae

a[1] Lower or outer surface of maxillary armed with a longitudinal series of denticulated ridges. Dorsal surface of frontal bones smooth except for having several small pores.

b[1] Molar teeth on jaws conspicuously large and stout, oval in shape. Premaxillary pedicel as long as base of premaxillary. *Monotaxis*

b[2] Jaws with a series of conical teeth laterally. Premaxillary pedicel longer than base of premaxillary. . . . *Gnathodentex*

a[2] Maxillary without denticulated ridge. Dorsal surface of frontal bones furnished with a number of low parallel ridges. *Gymnocranius*

Gymnocranius japonicus, *sp. nov.*

Siro-dai (New Japanese name)

(Figs. 1 and 2)

Holotype.—MIKU (Marine Biological Institute of Kyoto University) No. 1751, a mature male specimen, 318 mm in standard length, Nase market, Amami Oshima, July 10, 1958.

Paratypes.—MIKU No. 1752, immature male specimen, 210 mm, Akakina, Amami Oshima, July 11, 1958. FAKU (Department of Fisheries, Faculty of Agriculture, Kyoto University) No. 26416, immature male specimen, 286 mm, Kagoshima fish market, Sept. 4, 1956. FAKU No. 28428, mature female 291 mm, Okinawa, Nov., 1935.

Description.—Counts and proportional measurements of bodily parts of types are shown in Table 1. In this description the external characters are described from the holotype, and the internal ones are based upon the dissection of a paratype, 286 mm in standard length.

External: Body ovate, and well compressed. Dorsal profile of head gently arched. Eye relatively large. Nostrils 2 on each side, close to eye, the anterior one an ovoid slit with a thick fleshy flap. Preopercle smooth on both posterior and lower margins. Opercle not serrated, but with a rudimentary spine on the posterior edge (Fig. 1). Gill rakers on the first arch short, knob-like in shape, and each armed with a villiform patch of spinules on the inner surface (Fig. 2 C).

Mouth moderately large and slightly oblique. Maxillary extending below anterior nostril and largely hidden under preorbital bone. Jaws with a series of 2 or 3 enlarged canines on each side anteriorly and a broad band of villiform teeth on inner side of them. Continuous with these enlarged canines, the upper jaw with a longitudinal series of 2 molar-like conical teeth and 4 moderately large molar teeth. Behind a broad band of villiform teeth, lower jaw with 2 molar-like conical teeth, 3 molar teeth and 3 blunt conical teeth running in a longitudinal series (Fig. 2 A).

Dorsal spines relatively short and stout. First dorsal spine originating above a vertical line through base of pectoral. First anal

TABLE 1. COUNTS AND PROPORTIONAL MEASUREMENTS OF THE TYPES OF *Gymnocranius japonicus*

Items	Holotype	Paratypes		
Sp. No.	1751	26416	28428	1752
Sex	♂	♀	♂	♂
Standard length in mm	318.0	286.0	291.0	210.0
Dorsal fin	X, 10	X, 10	X, 10	X, 10
Anal fin	III, 10	III, 10	III, 10	III, 10
Pectoral fin	14	14	14	14
Pored scales on lateral line (on caudal)	49 (2)	49 (2)	49 (2)	49 (2)
Gill rakers on first arch	3 + 5 = 8	3 + 5 = 8	4 + 6 = 10	3 + 5 = 8
Pyloric caeca	—	3	—	3
Vertebrae	10 + 14 = 24	10 + 14 = 24	10 + 14 = 24	10 + 14 = 24
In standard length:				
Head length	2.93	2.83	2.84	2.82
Depth of body	2.47	2.42	2.44	2.33
Length of pectoral fin	3.54	3.43	3.44	3.34
In head length:				
Snout length	2.12	2.12	2.12	2.66
Maxillary length	2.93	2.78	2.77	3.10
Interorbital width	2.79	2.81	2.77	2.92
Eye diameter	3.94	3.58	3.80	3.26
Suborbital width	3.05	2.97	3.21	3.47
Pelvic fin length	1.36	1.27	1.37	1.49
4th dorsal spine length	3.10	2.97	3.06	3.04
4th dorsal soft ray length	1.97	1.91	1.91	2.16
3rd anal spine length	3.29	3.55	3.33	3.68
3rd anal soft ray length	2.19	2.30	2.15	2.40

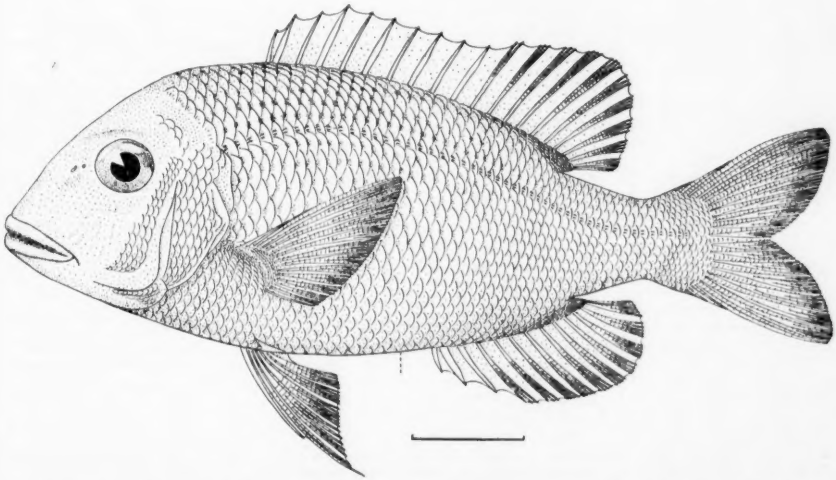

Fig. 1. Lateral aspect of holotype of *Gymnocranius japonicus* sp. nov. Scale bar indicates 50 mm.

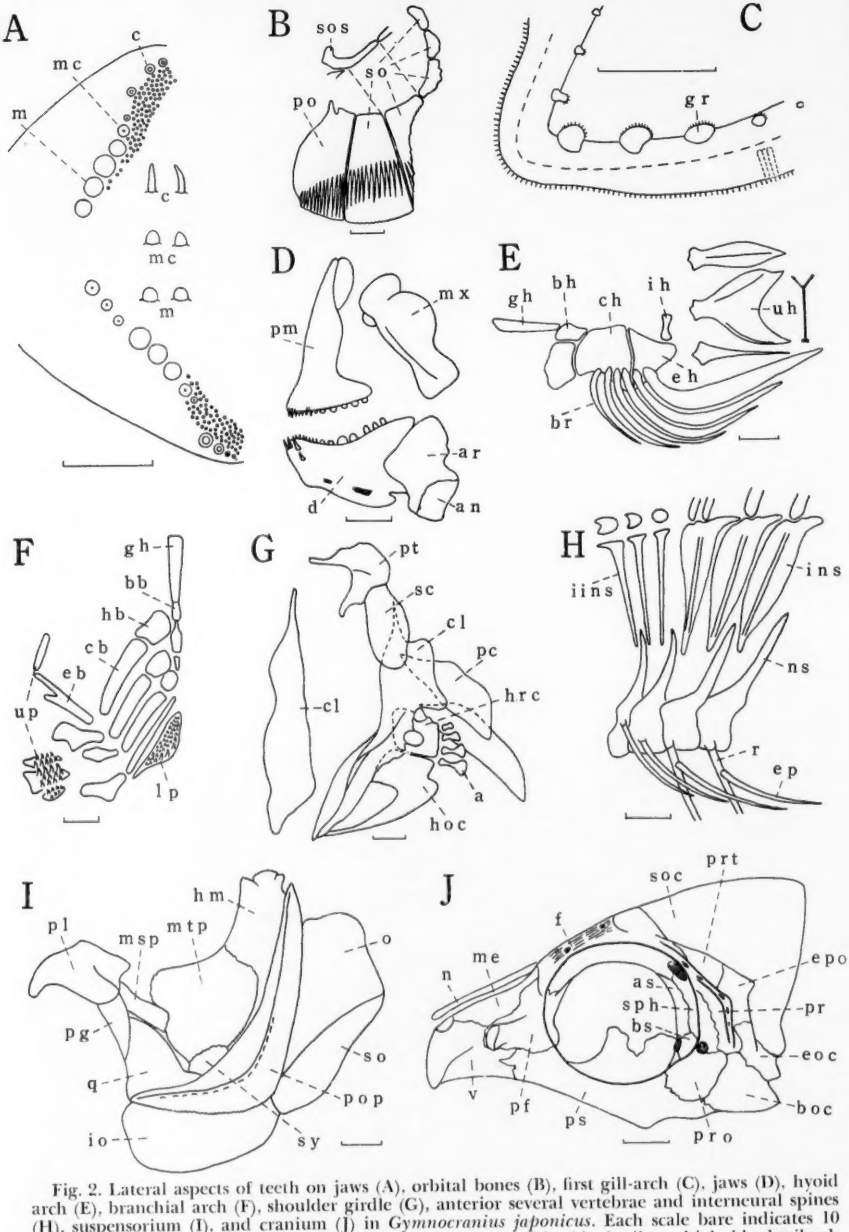

Fig. 2. Lateral aspects of teeth on jaws (A), orbital bones (B), first gill-arch (C), jaws (D), hyoid arch (E), branchial arch (F), shoulder girdle (G), anterior several vertebrae and interneural spines (H), suspensorium (I), and cranium (J) in *Gymnocranius japonicus*. Each scale bare indicates 10 mm a, actinosts; ar, articular; as, alisphenoid (pterosphenoid); bb, basibranchial; bh, basihyal; boc, basioccipital; br, branchiostegal ray; bs, basisphenoid; c, canine; cb, ceratobranchial; ch, ceratohyal; cl, clavicle; d, dentary; eb, epibranchial; eh, epihyal; eoc, exoccipital; ep, epipleural; epo, epiotic; f, frontal; gh, glossohyal; gr, gill-raker; hb, hypobranchial; hm, hyomandibular; hoc, hypocoracoid; hrc, hypercoracoid; ih, interhyal; iins, imperfect interneual spine; ins, interneural spine; io, interopercle; lp, lower pharyngeal; m, molar tooth; mc, molar-like conical tooth; me, mesethmoid; msp, mesopterygoid; mp, metapterygoid; mx, maxillary; n, nasal; ns, neural spine; o, opercle, pc, postclavicle; pf, prefrontal; pg, pterygoid; pl, palatine; pm, premaxillary; po, preorbital; o, preopercle; pr, pterotic; proc, prootic; prt, parietal; ps, parasphenoid; pt, post-temporal; q, quadrate; r, rib; sc, supraclavicle; so, suborbital; sph, sphenotic; soc, supraoccipital; sop, subopercle; sos, suborbital shelf; sy, symplectic; uh, urohyal; up, upper pharyngeal; v, vomer.

spine arises below first dorsal soft ray. Pectoral fin relatively short, scarcely reaching first anal spine. Pelvic fin inserted directly below base of pectoral fin, extending to between vent and first anal spine.

Scales large, feebly ctenoid. Predorsal scales extend to above posterior margin of orbit; interorbital region and preopercular flange naked. Interopercle covered with a patch of relatively small scales posteriorly. Base of soft dorsal and anal fins covered with a rather low scaly sheath.

In formalin, ground color of body uniformly whitish gray; head pale purple, becoming gray below. Basal parts of each scale above lateral line and anterior parts of body with dark gray spot about one-third as large as the scale. Pectoral fin slightly pinkish; other fins pale.

Internal: Premaxillary pedicel conspicuously developed, about 1.7 times as long as premaxillary lamina. Angle formed by premaxillary pedicel and the lamina about 65° (Fig. 2 D). Preorbital and first suborbital bones similar in size, quadrangular in shape and wider than long; lower parts of both preorbital and first suborbital bones unossified, their lower margins weakly denticulated. Suborbital shelf formed by second suborbital bone, small and boot-like in shape (Fig. 2 B). Palatine quadrangular, the anterior part projecting forward as a rod (Fig. 2 I). Frontals separated. Epiotics not bifurcated posteriorly. Parasphenoid with 2 well-developed processes on lower side. Opisthotic bone invisible as in *Chrysophrys major* (Tomiyama 1931). Cranium very high, but about 1.5 times as long as high (Fig. 2 J). Second basibranchial bone bottle-shaped and wider and longer than third which is bar-shaped (Fig. 2 F). Branchiostegal rays 6, the anterior 4 attached to lower side of ceratohyal, the fifth at the junction of ceratohyal and epihyal, and the last one on epihyal. Urohyal flat, triangular in shape, and the posterior margin lunate; upper part of urohyal bifurcate, and Y-shaped in cross section at the middle part (Fig. 2 E). Post-temporal large and U-shaped. Posterior margin of clavicle strongly emarginated immediately above hypercoracoid. Surface of inner margin of clavicle slightly but widely constricted at the middle (Fig. 2 G). Imperfect interneural spines 3 in number, upper head of the first spine heart-shaped. First and second interneural spines placed between second and third neural spine (Fig. 2 H). Pyloric caeca 3, short and robust. Stomach large and Y-shaped. Intestine burly and N-shaped.

Habitat and food habit.—The present species inhabits the littoral waters of the southern part of Japan, Kagoshima, and Okinawa. It is taken by Itoman's fishermen by a dribing-in net (Oikomi-ami), or a trinal net (Sanju sasi-ami), both operated near the rocky shores or reefs. The species is carnivorous; the stomach contents reveal that they feed on echinoderms and other small benthic animals.

Remarks.—This new species closely resembles the other species of *Gymnocranius* in some characters, e. g. the general form of ridges on the frontal bones and the shape of the jaws, but differs in having a series of molar teeth on the jaws and 4½ scales in a transverse series from the ninth dorsal spine to the lateral line except for 5½ on one specimen (a series of bluntly pointed conical teeth are present on the jaws, and scales above the lateral line are 5½ in other species of *Gymnocranius*: Bleeker, 1876–77; Fowler, 1933; Weber and de Beaufort, 1936). The Japanese name, Siro-dai means white sea bream, in reference to its coloration.

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Meristic Variation in the Fourspine Stickleback, *Apeltes quadracus*

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THE fourspine stickleback, *Apeltes quadracus* (Mitchill), has been named at least three times: *Gasterosteus quadracus* Mitchill, 1815 (original description); *Gasterosteus apeltes* Cuvier and Valenciennes, 1829; *Gasterosteus millepunctatus* Ayres, 1842. Mitchill's stickleback, ironically, had five dorsal spines, not four. Mitchill described a lateral spine on each side, extending from the pelvic spine to the vent. This, as DeKay (1842) later clarified, was the "os innominatum". Cuvier and Valenciennes interpreted this as an external structure, and thus described a second species, *G. apeltes*. Ayres' *millepunctatus* was based entirely on coloration. DeKay (1842) first proposed the use of the generic name *Apeltes*. In the last review of the Gasterosteidae, Eigenmann (1886) recognized only one species, *Apeltes quadracus*.

Meristic characters were generally ignored. Mitchill gave spine and ray counts for a single specimen. Cuvier and Valenciennes, and Ayres listed dorsal spines only. Eigenmann, too, ignored meristics, stating only that the "... single species has shown no important variation" (1886:248). Discrepancies between the fin ray counts given by Mitchill, DeKay, and Storer (1839), suggest that the species may be quite variable.

The purpose of this study has been to examine the nature and extent of meristic variation in *Apeltes quadracus*, with respect to possible infraspecific levels of speciation.

MATERIALS

More than 800 specimens of *Apeltes quadracus* were examined during the course of this study. These were obtained from Boston University (BU), Chesapeake Biological Laboratory, Maryland Department of Research and Education (CBL), Cornell University (CU), Museum of Comparative Zoology, Harvard University (MCZ), Royal Ontario Museum (ROM), and the United States National Museum (USNM).

Specimens examined: *Gulf of Saint Lawrence*—USNM 83651 (3, 50–58) Magdalen I.; Aug., 1917. *Prince Edward Island*—ROM 12713 (17, 27–44) Bideford River, Malpeque Bay; Sept. 12, 1934. *New Brunswick*—ROM 16569 (25, 25–46) Miramichi River at Newcastle; Je.-Nov., 1942. *Nova Scotia*—USNM 117692 (4, 30–50) Mitchell Bay, Halifax; Jul. 18, 1939. ROM 12152 (9, 32–41) Pond at Glasgow Head, Canso; Sept. 2, 1901. *Maine*—USNM 91423 (25, 28–48) Winter Harbor; Je. 2, 1915. MCZ 34173 (19, 25–38) Cranberry I.; Jul., 1931. USNM 83689 (25, 32–44) Porters Lodge Creek, Freeport; Oct. 21, 1906. USNM 13915 (2, 33–45) Casco Bay, Portland; 1873. *Massachusetts*—MCZ 6742 (26, 22–35) Salem. BU WHK5946 (25, 34–50) Broad Cove, 0.6 mi. N of Hingham Center on Mass. rte. 3A, Hingham; Je. 11, 1959. BU WHK5948 (7, 32–39) salt bay on Eastman Road off Mass. rte. 128, North Cohasset; Je. 11, 1959. BU WHK5956 (23, 18–42) South River, at jct. Willow and Ocean Streets, Marshfield; Je. 30, 1959. BU RHG5932 (10, 29–38) Lewis Pond and Macombers Creek, Marshfield Hills; Apr. 26, 1959. MCZ 6762 (9, 26–32) Provincetown; 1870. MCZ 6700 (9, 33–49) Provincetown. CU 31175 (22, 21–34) Pond 0.1 mi. N jct. Mass. rte. 28 on Mass. rte. 149, Barnstable Co.; Je. 23, 1957. BU WHK5961 (30, 22–44) Quahog Pond Stream, on dirt road off Mass. rte. 28 at Seagull Restaurant, N of Falmouth; Aug. 24, 1959. CU 13187 (25, 19–34) Sippiwisset, Barnstable Co.; Aug. 21, 1947. CU 30469 (25, 18–31) Coonamesset River at Mass. rte. 28, Falmouth; Aug. 22, 1956. *Connecticut*—USNM 14002 (17, 18–29) Ram Point, Noank; Sept. 19, 1874. CU 34085 (3, 22–38) W arm Niantic Bay; Oct. 26, 1955. *New York*—CU 27020 (25, 28–36) Rensselaer; Sept. 4, 1934. MCZ 6725 (17, 19–28) Rye Beach; 1860. CU 22817 (20, 24–41) Acabonack Harbor, Springs; Mar. 28, 1952. BU WHK5964 (18, 23–32) creek flowing into Lake Montauk at Montauk Airport, East Lake Drive, Montauk; Sept. 11, 1959. CU 6289 (25, 21–40) Middle Pond, Atlantic Drive, Suffolk Co.; Jul. 12, 1938. CU 26861 (11, 18–37) Bergen Beach, Long Island; 1938. CU 27330 (4, 36–38) Coeyman's Creek, near mouth, Coeymans, Suffolk Co.; Aug. 29, 1934. CU 30299 (4, 23–27) Peconic River, 0.3 mi. S jct. RR and Edwards Ave.; July 7, 1956. CU 33200 (6, 24–35) Connetquot River, at Veteran's Memorial Hwy., Suffolk Co.; Sept. 20, 1958. CU 23614 (25, 27–42) Babylon, Suffolk Co.; Sept. 12, 1948. CU 23635 (13, 22–38) 15 mi. E of Lindenhurst, L. I.; July 15, 1948. *Pennsylvania*—MCZ 6680 (25, 22–40) Schuylkill River. CU 29603 (1, 40) Harvey's Lake, Luzerne Co.; Je., 1951. *New Jersey*—MCZ 6750 (25, 22–32) Somers Point; 1864. USNM 118377 (25, 26–46) Barnegat Bay, off Waretown; Apr. 19, 1932. MCZ 34426 (5, 38–44) Barnegat Bay; Sept. 10, 1930. *Maryland*—USNM 91175 (15, 31–43) Oxford; Sept. 10, 1931. CU 14198 (1, 42) Chesapeake Bay, near Solomons; Je. 14, 1937. USNM 91169 (22, 29–56) Solomons; Je. 28, 1922. CU 23573 (25, 22–34) Patuxent River at Solomons I.; Aug. 27, 1953. CU 23524 (25, 20–26) Patuxent River at Sollers Point; Aug. 27, 1953. CU 14170 (4, 24–27) Point Patience, Solomons; Jul. 2, 1936. CBL 1 (25, 26–43) CBL pier area; Feb. 11, 1959. CBL 2 (25, 22–34) CBL pier area; Je. 18, 1959. CBL 3 (25, 24–36) CBL pier area; Oct. 21, 1959. *Virginia*—CU 9898 (12, 30–48) Rappahannock River, at Fredericksburg; Mar. 28, 1941. USNM

91168 (18, 34–46) Rappahannock River, Corrotoman River and Mosquito Point; Apr. 17–20, 1922. USNM 91170 (9, 33–47) York River, below Yorktown; Apr. 13–15, 1922.

Methods

Random samples, comprising at least 25 specimens wherever possible, were counted from collections representing localities throughout the range of *Apeltes quadracus,* from the Maritime Provinces of Canada to Virginia. Counts were made of the total number of dorsal spines, dorsal fin rays, and anal fin rays. Early in the study it was found that caudal and pectoral rays were relatively invariable; thus these two counts were abandoned. To ascertain whether any correlation might exist between vertebrae and the other characters considered, samples were used from nine collections which represented a wide range of habitats, as well as a wide range in spine and ray counts. These were X-rayed on Kodak Ortho film at 58 killivolts and seven milliamperes, with an exposure time of five minutes. The vertebrae were then counted from the negatives under the dissecting microscope. Due to limitations in the apparatus and/or technique, only the larger specimens, with a standard length of 30 mm or more, could be accurately counted. Even in the larger specimens the caudal vertebrae were sometimes too indistinct to give a reliable count, and these particular specimens were omitted. Thus most sample counts of vertebrae are smaller than the corresponding spine and ray counts.

To show the relationship among vertebrae, spines and rays, correlation coefficients (r) were obtained using the method outlined by Snedecor (1953:138–41). For this aspect of the study 38 collections were examined.

Tables 1–4, with samples arranged in geographical order from north to south, give the frequency distributions of the characters examined. A map is included showing the distribution of collections.

Variation in *Apeltes quadracus*

A typical or modal fourspine stickleback has 32 vertebrae, 12 dorsal rays, nine anal rays, and four dorsal spines, with one spine attached to the anterior edge of the soft dorsal fin and three free spines in front of it. Vertebrae were found to vary from 30 to 33, dorsal rays from nine to 14, anal rays from seven to 11, and dorsal spines from two to six. Only one specimen was found to have two spines, and this was clearly an abnormality; the first and fourth spines were perfectly developed, while numbers two and three were represented by small dermal papillae, indicating arrested development.

The pattern of variation was in general extremely irregular. No significant correlation between vertebrae and the other characters considered was apparent. Correlation coefficients obtained for vertebrae and spines, vertebrae and dorsal rays, and vertebrae and anal rays were −0.374, −0.381, and −0.019, respectively. Similarly, no significant correlation was found between spines and dorsal rays, or between spines and anal rays, with coefficients of −0.238 and −0.134, respectively. Good correlation was obtained, however, between dorsal and anal rays, where $r = 0.747$. Explanations for this pattern of variation will be attempted later.

Table 1 indicates a slight tendency for the number of vertebrae to decrease in clinal fashion from north to south. Spines and dorsal and anal rays show no such tendency; Tables 2, 3 and 4 show that these characters vary in an irregular manner from north to south, with no significant differences between values at either end of the range. In-

Table 1. Frequency Distribution of Vertebrae in *Apeltes quadracus*

Collections arranged in order from north to south.

Locality	30	31	32	33	N	$\bar{X}$	SD	SE
Miramichi R., N.B.	1	2	11	4	18	32.00	.767	.181
Winter Harbor, Me.	1	3	15	1	20	31.80	.616	.138
Broad Cove, Mass.		7	13	3	23	31.83	.650	.136
Barnstable, Mass.		11	4		15	31.07	.258	.067
Schuylkill R., Penn.		8	12	2	22	31.73	.631	.134
Barnegat Bay, N.J.		3	19	1	23	31.91	.417	.087
Oxford, Md.		6	9		15	31.60	.507	.131
Rappahannock R., Va.	1	4	10	2	17	31.76	.752	.182
York R., Va.	2	5	2		9	31.00	.707	.236

TABLE 2. FREQUENCY DISTRIBUTION OF DORSAL SPINES IN *Apeltes quadracus*
Collections arranged in order from north to south.

Locality	2	3	4	5	6	N	$\bar{X}$	SD	SE
Magdalen I., G. St. L.			3			3	4.0	—	—
Bideford R., P.E.I.			11	6		17	4.35	.492	.119
Miramichi R., N.B.			2	23		25	4.92	.277	.055
Mitchell Bay, N.S.			3	1		4	4.25	.500	.250
Canso, N.S.			5	4		9	4.44	.527	.176
Winter Harbor, Me.			25			25	4.00	—	—
Cranberry I., Me.			16	3		19	4.16	.374	.086
Freeport, Me.			17	8		25	4.32	.476	.095
Casco Bay, Me.			2			2	4.00	—	—
Salem, Mass.			24	2		26	4.08	.272	.053
Broad Cove, Mass.			25			25	4.00	—	—
N. Cohasset, Mass.			6	1		7	4.14	.378	.143
Marshfield H., Mass.			9	1		10	4.10	.316	.100
South R., Mass.		1	20	2		23	4.04	.366	.076
Provincetown, Mass.		1	10	7		18	4.33	.577	.136
Barnstable, Mass.			4	18		22	4.82	.395	.084
Quahog Pd. Str., Mass.		1	25	4		30	4.10	.402	.073
Sippiwisset, Mass.		3	20	2		25	3.96	.520	.104
Coonamesset R., Mass.	1	2	13	9		25	4.20	.764	.153
Ram Point, Conn.			14	3		17	4.12	.416	.101
Niantic Bay, Conn.			3			3	4.00	—	—
Renesslaer, N.Y.		1	18	6		25	4.20	.500	.100
Rye Beach, N.Y.			17			17	4.00	—	—
Acabonack Har., N.Y.			19	1		20	4.05	.224	.050
Montauk, N.Y.			16	2		18	4.22	.324	.076
Middle Pond, N.Y.		1	24			25	3.96	.200	.040
Peconic R., N.Y.				3	1	4	5.25	.500	.250
Connetquot R., N.Y.				6		6	5.00	—	—
Coeymans Cr., N.Y.			3	1		4	4.25	.500	.250
Babylon, N.Y.		2	22	1		25	3.96	.351	.070
Lindenhurst, N.Y.		1	11	1		13	4.00	.409	.113
Bergen Beach, N.Y.			3			3	4.00	—	—
Bergen Beach, N.Y.			9	2		11	4.18	.405	.122
Schuylkill R., Penn.			3	21	1	25	4.92	.400	.080
Harvey's Lake, Penn.				1		1	5.00	—	—
Somers Pt., N.J.			24	1		25	4.04	.200	.040
Barnegat Bay, N.J.		5	17	3		25	3.92	.572	.114
Barnegat Bay, N.J.			5			5	4.00	—	
Oxford, Md.			9	6		15	4.40	.507	.131
Solomons, Md.			8	14		22	4.64	.492	.105
Chesapeake Bay, Md.				1		1	5.00	—	—
Pt. Patience, Md.		1	1	2		4	4.25	.917	.479
CBL Pier, Md.			9	16		25	4.64	.490	.098
CBL Pier, Md.			13	12		25	4.48	.501	.100
CBL Pier, Md.			11	14		25	4.56	.507	.101
Patuxent R., Md.			12	13		25	4.52	.501	.100
Patuxent R., Md.			5	19	1	25	4.84	.472	.094
Rappahannock R., Va.			5	7		12	4.58	.458	.132
Rappahannock R., Va.			9	9		18	4.50	.515	.121
York R., Va.			4	4	1	9	4.67	.707	.236

TABLE 3. FREQUENCY DISTRIBUTION OF DORSAL FIN RAYS IN *Apeltes quadracus*
Collections arranged in order from north to south.

Locality	9	10	11	12	13	14	N	$\bar{X}$	SD	SE
Magdalen I., G. St. L.				3			3	12.00	—	—
Bideford R., P.E.I.			9	8			17	11.47	.515	.125
Miramichi R., N.V.		2	16	6	1		25	11.24	.663	.133
Mitchell Bay, N.S.			2	1	1		4	11.75	.958	.479
Canso, N.S.		1	5	3			9	11.22	.667	.222
Winter Harbor, Me.			13	10	2		25	11.56	.650	.130
Cranberry I., Me.		4	6	8	1		19	11.32	.885	.203
Freeport, Me.		1	11	12	1		25	11.52	.653	.131
Casco Bay, Me.			1	1			2	11.50	.707	.500
Salem, Mass.		1	10	14	1		26	11.58	.643	.126
Broad Cove, Mass.	1	4	9	11			25	11.20	.866	.173
N. Cohasset, Mass.			5	2			7	11.20	.488	.184
Marshfield H., Mass.			1	7	2		10	12.10	.567	.179
South R., Mass.			7	16			23	11.68	.470	.098
Provincetown, Mass.		2	5	8	3		18	11.67	.908	.214
Barnstable, Mass.			6	11	5		22	11.82	.722	.154
Quahog Pd. Str., Mass.	1	3	16	10			30	11.17	.747	.136
Sippiwisset, Mass.			12	9	4		25	11.68	.748	.150
Coonamesset R., Mass.		1	8	13	3		25	11.72	.737	.147
Ram Point, Conn.			10	7			17	11.41	.508	.123
Niantic Bay, Conn.			1	1	1		3	12.00	1.000	.577
Rensselaer, N.Y.		4	18	3			25	10.96	.538	.108
Rye Beach, N.Y.		2	6	7	2		17	11.53	.875	.212
Acabonack Har., N.Y.			11	8	1		20	11.50	.607	.136
Montauk, N.Y.		1	3	13	1		18	11.78	.646	.152
Middle Pond, N.Y.		1	6	16	2		25	11.76	.663	.133
Peconic R., N.Y.				3	1		4	12.25	.500	.250
Connetquot R., N.Y.			1	3	2		6	12.17	.752	.307
Coeymans Cr., N.Y.	1	1	2				4	10.25	.958	.479
Babylon, N.Y.			4	15	6		25	12.08	.640	.128
Lindenhurst, N.Y.				6	7		13	12.54	.519	.144
Bergen Beach, N.Y.		1	4	6			11	11.45	.688	.207
Bergen Beach, N.Y.		1		2			3	11.33	1.160	.697
Schuylkill R., Penn.	1	0	13	11			25	11.36	.700	.140
Harvey's Lake Penn.				1			1	12.00	—	—
Somers Pt., N.J.			3	17	4	1	25	12.12	.666	.133
Barnegat Bay, N.J.			4	11	10		25	12.24	.733	.147
Barnegat Bay, N.J.				5			5	12.00	—	—
Oxford, Md.			7	7	1		15	11.60	.640	.165
Solomons, Md.		1	12	5	3	1	22	11.59	.959	.204
Chesapeake Bay, Md.					1		1	13.00	—	—
Pt. Patience, Md.			1	3			4	11.75	.500	.250
CBL Pier, Md.		2	12	9	1	1	25	11.48	.871	.174
CBL Pier, Md.		2	9	12	2		25	11.56	.768	.154
CBL Pier, Md.		1	10	12	2		25	11.60	.707	.141
Patuxent R., Md.		3	12	8	2		25	11.36	.811	.162
Patuxent R., Md.		3	8	13	1		25	11.48	.770	.154
Rappahannock R., Va.			3	6	3		12	12.00	.707	.204
Rappahannock R., Va.			8	8	2		18	11.66	.686	.162
York R., Va.			1	8			9	11.89	.331	.110

TABLE 4. FREQUENCY DISTRIBUTION OF ANAL FIN RAYS IN *Apeltes quadracus*
Collections arranged in order from north to south.

Locality	7	8	9	10	11	N	$\bar{X}$	SD	SE
Magdlen I., G. St. L.			1	2		3	9.67	.579	.334
Bideford R., P.E.I.		5	10	2		17	8.82	.636	.154
Miramichi R., N.B.		6	17	2		25	8.84	.554	.111
Mitchell Bay, N.S.			3	1		4	9.25	.500	.250
Canso, N.S.	1	5	2	1		9	8.33	.866	.289
Winter Harbor, Me.	1	8	14	2		25	8.68	.689	.138
Cranberry I., Me.	2	9	7	1		19	8.37	.761	.174
Freeport, Me.		8	13	4		25	8.84	.688	.138
Casco Bay, Me.				2		2	10.00	—	—
Salem, Mass.	1	10	13	2		26	8.62	.697	.137
Broad Cove, Mass.		10	12	3		25	8.72	.678	.136
N. Cohasset, Mass.	1	3	2	1		7	8.43	.976	.369
Marshfield H., Mass.		3	4	3		10	9.00	.817	.258
South River, Mass.	1	8	10	4		23	8.74	.810	.169
Provincetown, Mass.	2	2	12	2		18	8.78	.809	.191
Barnstable, Mass.		2	16	3	1	22	9.14	.639	.136
Quahog Pd. Str., Mass.		7	20	3		30	8.87	.572	.104
Sippiwisset, Mass.		8	15	2		25	8.76	.554	.111
Coonamesset R., Mass.		8	13	4		25	8.84	.688	.138
Ram Point, Conn.	1	7	9			17	8.47	.625	.151
Niantic Bay, Conn.			2	1		3	9.33	.579	.334
Rensselaer, N.Y.	2	13	8	2		25	8.40	.764	.153
Rye Beach, N.Y.		3	9	5		17	9.12	.696	.169
Acabonack Har., N.Y.		4	14	2		20	8.90	.552	.123
Montauk, N.Y.		3	8	6		18	9.28	.826	.195
Middle Pond, N.Y.		6	14	5		25	8.96	.676	.135
Peconic R., N.Y.		1	1	2		4	9.25	.958	.479
Connetquot R., N.Y.		2	3	1		6	8.83	.752	.307
Coeyman's Cr., N.Y.		3	1			4	8.25	.500	.250
Babylon, N.Y.		2	14	9		25	9.28	.614	.123
Lindenhurst, N.Y.		1	6	6		13	9.38	.650	.180
Bergen Beach, N.Y.		2	7	2		11	9.00	.633	.191
Bergen Beach, N.Y.		2	1			3	8.33	.579	.334
Schuylkill R., Penn.	1	10	14			25	8.52	.586	.117
Harvey's Lake, Penn.		1				1	8.00	—	—
Somers Point, N.J.		1	12	11	1	25	9.48	.653	.131
Barnegat Bay, N.J.	1	2	7	12	3	25	9.56	.961	.192
Barnegat Bay, N.J.			3	2		5	9.40	.548	.245
Oxford, Md.	1	6	6	2		15	8.60	.828	.214
Solomons, Md.		4	15	3		22	8.95	.575	.123
Chesapeake Bay, Md.			1			1	9.00	—	—
Pt. Patience, Md.			3	1		4	9.25	.500	.250
CBL Pier, Md.		5	15	5		25	9.00	.646	.129
CBL Pier, Md.		12	9	3	1	25	8.72	.843	.168
CBL Pier, Md.		11	10	4		25	8.72	.737	.147
Patuxent R., Md.	1	8	12	3	1	25	8.80	.866	.173
Patuxent R., Md.		4	16	5		25	9.04	.611	.122
Rappahannock R., Va.		2	7	2	1	12	9.17	.565	.163
Rappahannock R., Va.		2	9	7		18	9.28	.669	.158
York River, Va.		1	8	9		9	9.89	.331	.110

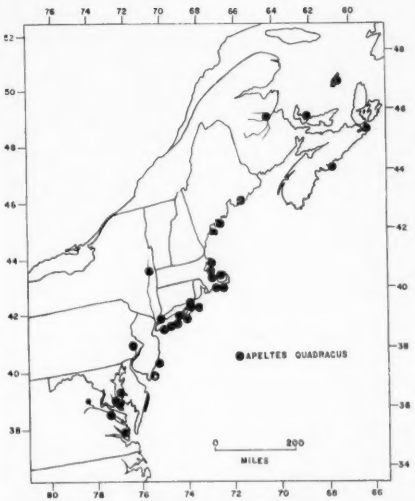

Fig. 1. Map showing the distribution of collections examined of *Apeltes quadracus*. Each dot represents one or more collections.

dividual differences between populations, however, are considerable. On the basis of the criteria used by some systematists, *Apeltes quadracus* could be divided into several subspecies and races. Ginsburg (1938) proposed that species, subspecies and races be separated on the basis of the degree of divergence of the principal character—the character which shows the greatest divergence. With dorsal rays as the principal character, Table 3 shows that the New York collections of Rensselaer and Babylon diverge 86%. This is at the upper limit of Ginsburg's criterion for subspecies. The Babylon and Acabonack Harbor, New York samples diverge 64.5%, well within Ginsburg's criterion for races. Similarly, the Schuylkill River, Pennsylvania and Somers Point, New Jersey samples diverge 72%, above the upper limit set by Ginsburg for races.

Tables 2 and 4 show that dorsal spines and anal rays could be used to separate these populations in similar fashion.

Ignoring those samples which are too small to afford significance (Peconic River, Connetquot River and Coeymans Creek), the New York populations from Rensselaer through Lindenhurst appear to form a cline with respect to dorsal rays. As the distribution map shows, many gaps exist between collections along the range of the species. More extensive sampling might well reveal the presence of numerous other local clines.

Where gradients exist, no nomenclatorial status should be applied to the populations concerned. Furthermore, for any two given populations of *Apeltes quadracus*, no matter how widely divergent, any number of intergrading populations can be found throughout the range of the species. It seems probable that the variation encountered is environmental and not genetic; thus none of the populations should be named.

Discussion

Numerous field and experimental studies have revealed correlations between environmental factors and meristic characters in fishes. Schmidt (1917, 1919) showed experimentally that the number of dorsal rays in *Lebistes reticulatus* increased with increasing temperature. Schultz (1926) found that the number of anal rays in *Notemigonus crysoleucas* increased from north to south, although caudal vertebrae and lateral-line scales showed no such correlation. In contrast, Hubbs (1922) found that the vertebrae, lateral-line scales and anal rays of *Notropis atherinoides* showed significantly higher counts at lower temperatures, while *Lepomis macrochirus* showed a similar correlation for vertebrae, dorsal spines, and dorsal and anal rays. Weisel (1955) found that while the dorsal and anal rays of two cyprinids, *Richardsonius balteatus* and *Ptychocheilus oregonensis* tended to vary inversely with water temperature, the correlation was far from perfect, and many local exceptions existed. Schmidt's (1920) work on the effect of temperature and salinity on the number of vertebrae in *Zoarces viviparus* revealed that while a change could be induced in a population under different conditions, no difference appeared between two populations under the same conditions. Schmidt (1921) showed that the vertebrae of *Salmo trutta* were fewest at an intermediate temperature, and increased in number at both higher and lower temperatures. Gabriel (1944) and Dannevig (1950) obtained an increase in the number of vertebrae with decreasing temperature in *Fundulus heteroclitus* and *Pleuronectes platessa*, respectively.

These studies illustrate the point that at present, no simple rule can be formulated to explain the effect of the environment on all fishes.

Most pertinent to this paper are the experimental studies of Taning (1952) and Heuts (1947, 1949). Taning produced statistically significant differences in numbers of vertebrae and fin rays in *Salmo trutta* by varying temperature during development. He found that each meristic character has its own phenocritical period—a period during development when a change in temperature is most effective in altering the final number of segments laid down. The number of vertebrae, and in part the number of anal rays, are mainly determined genotypically, since their phenocritical periods occur early in ontogeny and are short. Dorsal and pectoral rays, with later and longer phenocritical periods, are influenced by environmental factors to a far greater extent.

Heuts (1947) experimented with two Belgian populations of *Gasterosteus aculeatus*, a freshwater population, with low mean plate numbers (type A), and a saltwater population, with high plate numbers (type B). He found that selection favors both the adults and zygotes of each type in their respective salinities, producing two adaptive peaks. Reciprocal crosses of the A and B types produced eggs with salinity tolerances resembling that of the female parent, thus preventing an intermediate adaptive peak. While plate numbers and vertebrae were distinctly different in the A and B types, the number of fin rays was essentially the same. Heuts (1949) was able to induce wide means in fin ray numbers by varying the temperature of the A type eggs at low salinities, and of the B type eggs at high salinities. In both cases, higher means were produced at low temperatures. Thus both forms are similarly modifiable within their own habitats.

The findings of Taning and Heuts may be interrelated and applied to *Apeltes quadracus*, to offer a plausible explanation for the pattern of variation in this species.

Table 1 reveals that, with respect to number of vertebrae, only the Barnstable, Mass. and York River, Va. collections are out of line, with modes of 31 rather than 32 and consequently lower means. However, the difference between the two most divergent means is only one vertebra. Taning (1952) was able to produce a mean difference of 1½ vertebrae by a change of 6° C during the phenocritical period, and a difference of 3.2 vertebrae with a greater change in temperature, all in offspring from the same parents. The low means in the Barnstable and York River collections could then conceivably be explained by a low water temperature during development, perhaps early in the spawning season.

The close correlation between dorsal and anal rays in *Apeltes* indicates that their phenocritical periods probably coincide. In Taning's words, "If . . . there is a certain correlation between a couple of characters, it is partly due to the fact that the characters considered are determined more or less at the same time during the ontogeny" (1952:180). If the number of dorsal and anal rays is determined phenotypically, then an explanation for the wide diversity of means encountered in these characters may lie in the diversity of the species' habitat. The sticklebacks examined in this study represent populations which range all the way from the coastal sea up into rivers and ponds well above tidewater. Most of the collections were made in bays, harbors, tidal creeks and river mouths, where the salinity is certainly variable. While no figures are available to support this, it seems logical that for any given locality along the coast the temperatures of fresh water and sea water will seldom agree. Thus where these waters merge, the tide may produce wide ranges in temperature twice daily. Although Taning did not divulge the effect of a sudden change in temperature on fin rays, he was able to produce a mean difference of 2½ anal rays in progeny reared at different constant temperatures.

Length of spawning season must also be considered. I have examined male *Apeltes* in breeding color as early as April 26 in Massachusetts. Kuntz and Radcliffe (1915:134) took gravid females at Woods Hole as late as July 24. Certainly a wide range in water temperatures must occur over this period, with perhaps a wide range in the number of fin rays produced as an immediate result. Year-to-year temperature differences may produce even greater variation in any given locality.

Dorsal spines show no correlation with any of the other characters considered here. A correlation does exist, however, between spine number and salinity.

Cox (1923) reported that the percentage of five-spined individuals of *Apeltes* in the Maritime Provinces of Canada increased remarkably with a decrease in salinity. The present study indicates that this may be a widespread situation. While salinity data are generally unavailable, those collections taken from waters which are probably fresh, such as the Miramichi River in New Brunswick, the

pond at Barnstable, Mass., the Schuylkill River in Pennsylvania and the Peconic River in New York, show strong modes of five spines. Conversely, those from waters of probable high salinities, such as the four from Maine, the Broad Cove and Provincetown samples from Massachusetts, and the Somers Point and Barnegat Bay samples from New Jersey, show a strong mode of four spines. In the three collections from the Chesapeake Biological Laboratory pier area, where Beaven (1960) reports salinities varying from 5.4 to 20.4‰, four and five-spined individuals occur in about equal numbers.

The correlation is far from perfect. The Rensselaer sample from New York shows a clear mode of four spines. No locality is given, but these specimens were almost certainly taken from the Hudson River or one of its tributaries, presumably above tidewater. Similarly, the South River, Mass. sample—again with a mode of four spines—was taken at about the upper limit of tidewater along with *Esox niger, Notropis bifrenatus, Notemigonus crysoleucas* and *Lepomis gibbosus*. Fourspine sticklebacks in breeding condition have been collected in Lewis Pond, Mass. by me and by others. This pond is distinctly fresh, containing *Ictalurus nebulosus, Perca flavescens* and *Notemigonus crysoleucas*. Here again a mode of four spines was found. Due to the depth and turbidity of the water, actual spawning could not be observed. It is conceivable that the sticklebacks were not spawning, but had merely wandered into the pond, which was then accessible only at high tide via a tidal creek into which it drains. Numerous sticklebacks in breeding condition were found in the creek.

Knowledge of the local migrations of *Apeltes* is non-existent. Granted that the wandering behavior hypothesized above is possible, then the discrepancies encountered in the Rensselaer and South River samples might similarly be explained by migration. The Rensselaer collection may have been taken just above tidewater; the South River fish were very near to salt water.

It should also be noted that newly hatched *Apeltes* larvae show no trace of dorsal spines. These larvae may be swept down to salt water before spine formation begins. At the South River locality cited above, the proximity to the sea plus strong currents at ebb tide make this a very real possibility.

Granted that exceptions do exist, there nevertheless is a correlation between spine number and salinity. There may exist in *Apeltes quadracus* a mechanism similar to that discovered by Heuts in *Gasterosteus aculeatus*; namely, that individuals with low spine numbers are selected at high salinities, and those with high spine numbers are selected at low salinities. This conviction is somewhat strengthened by the fact that all the six-spined individuals were taken from waters either unmistakably fresh or on the fresh side of brackish, while nearly all the three-spined individuals came from waters near the other end of the salinity scale. As Heuts has shown, such a mechanism can work quite independently of fin ray determination.

The evidence also supports the possibility that spine numbers are determined directly by salinity. For the present, I feel that choosing between the two is a matter of preference. Other less plausible explanations could be given; spine numbers could be genetically determined irrespective of salinity, or may be a function of temperature, as appears to be the case with fin rays. A knowledge of the sequence of determination of the various characters would be very useful here.

Summary

The fourspine stickleback shows a variation of 30–33 vertebrae, 9–14 dorsal fin rays, 7–11 anal fin rays, and 2–6 dorsal spines. No correlation exists between any of the characters except dorsal and anal rays, which are strongly correlated.

Vertebrae tend to decrease in number from north to south, while dorsal and anal rays and dorsal spines vary irregularly throughout the range of the species.

The findings of Taning and Heuts have been employed to explain the pattern of variation. The variation in mean vertebral numbers may be due to the temperature lability of a single genotype. Dorsal and anal rays probably develop at about the same time in ontogeny and may be highly modifiable by temperature.

Dorsal spines are correlated with salinity. A selective mechanism similar to that described by Heuts in *Gasterosteus aculeatus* is believed responsible.

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Notropis semperasper, a New Cyprinid Fish from the Upper James River System, Virginia

Carter R. Gilbert

While examining a collection of fishes I had made in the upper James River system of western Virginia in June, 1956, five specimens of an apparently undescribed species of *Notropis* were discovered. A check of the collections at the University of Michigan Museum of Zoology revealed nine other individuals of this form, collected in 1928 by Dr. Carl L. Hubbs, and which had been recognized by him to be new. Thirty-four additional specimens were taken in the same area in September, 1957, and these, together with 10 individuals in the United States National Museum and the 14 referred to above, form the basis for the following description.

Although all the above were taken either

in Potts or Dunlap creeks, headwater tributaries of the upper James (Jackson) River, in Alleghany County, Virginia, further collecting, as well as a thorough check of other collections, probably will show the new species to be present in neighboring tributaries of this system, both in Virginia and West Virginia. However, since no specimens have been found in numerous collections from the Roanoke, New and Potomac drainages, or elsewhere in the James basin, it is apparent that this fish occupies a very restricted range. It is the second known endemic to the James River system.

Counts and measurements for all specimens were made according to the methods outlined by Hubbs and Lagler (1947:8–15). Measurements are expressed in thousandths of standard length. The photographs for Fig. 1 were made by the photographic laboratory of the Smithsonian Institution.

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Notropis semperasper, *n. sp.*
Roughhead shiner
(Fig. 1A)

Material.—Holotype, an adult, University of Michigan Museum of Zoology (UMMZ) 174815, 59 mm in standard length, from Potts Creek, just above junction with Jackson River (James River system), at state highway 18 bridge, near outskirts of Covington, Alleghany County, Virginia; collected June 14, 1956, by Carter R. Gilbert and John W. Moule. Paratypes, all from the above drainage, Alleghany County, Virginia (numbers in parentheses indicate numbers of specimens): UMMZ 174816 (4), 42–49 mm, taken with holotype; UMMZ 175100 (10), 31.5–61 mm, same locality as holotype, Sept. 13, 1957, Carter R. Gilbert and Donal G. Myer; UMMZ 95199, 95458 (9), 32–53.5 mm, Dunlap Creek, W of Covington, Sept. 10, 1928, Carl L. and Laura C. Hubbs; UMMZ 175076 (6), 44.5–61 mm, Dunlap Creek, just N of Earlehurst, 2.5 mi. S of jct. of st. hwys. 159 and 311, Sept. 13, 1957, Gilbert and Myer; UMMZ 175118 (14), 44–62 mm, Potts Creek, ca. 1.5 mi. SW of Blue Spring Run, at county road 614 bridge, Sept. 13, 1957, Gilbert and Myer; UMMZ 175133 (4), 33–47 mm, Dunlap Creek, 3 mi. WNW of Covington, at jct. of U. S. hwy. 60 and county rd. 600, Sept. 13–14, 1957, Gilbert and Myer; United States National Museum (USNM) 162868 (10), Dunlap Creek, 1 mi. S of Crows, on st. hwy. 311, April 27, 1952, Ernest A. Lachner, William Leapley, and Frank J. Schwartz.

Diagnosis.—A species of *Notropis,* apparently closely related to *Notropis scepticus,* but differing from that species in the following characters: granular nuptial tubercles present on the heads of individuals of both sexes (slightly better developed and more numerous in males) and on specimens at least as small as 28 mm standard length; more lateral-line and predorsal scales; upper margin of lateral stripe on anterior part of body extending about half the distance from lateral line to middorsal line; no light area above lateral stripe on caudal peduncle; postdorsal stripe broader and usually complete; maximum size smaller. The above characters are presented in Table 1.

Notropis semperasper has 2,4–4,2 pharyngeal teeth, with often only a single tooth present in the outer row on one or both sides; anal rays 10 or 11 (usually 10); lateral-line scales usually 38 to 41 (range 37 to 43); predorsal scales usually 20 to 23 (range 18 to 27; nape partially naked on one specimen examined), these scales often irregular and difficult to count; circumferential scales usually 26 to 29 (range 26 to 31); eye moderately large, diameter of orbit averaging about 9.5% of standard length (range 8.9 to 10.0%); dull silvery, or plumbeous, pigment in lateral stripe extending about half the distance from lateral line to middorsal stripe; peritoneum covered by large, more or less irregularly shaped patches of dark brown pigment, with the underlying silvery color barely showing between; pigment present on anterior part of underside of head, extending posteriorly to and occasionally on, anterior part of gular area, and a short distance farther posteriorly along outer side of mandible.

Description.—All pertinent counts and measurements are given in Tables 3 and 4. Characters of value in distinguishing *N. semperasper* from *N. scepticus* and *N. amoenus* are presented in Tables 1 and 2. Characters mentioned in the diagnosis are not repeated in the following description.

A species of moderate size, the largest specimens examined (a male and female) measuring 62 mm in standard length; body terete and moderately slender; mouth fairly large, the corners situated beneath anterior margin

TABLE 1. COMPARISON OF DISTINGUISHING CHARACTERS IN *Notropis semperasper* AND *Notropis scepticus*

Character	*Notropis semperasper*	*Notropis scepticus*
Position of upper margin of lateral stripe on anterior part of body	About half the distance from lateral line to middorsal line	About two-fifths the distance from lateral line to middorsal line
Postdorsal stripe	Broader; usually complete	Narrower; often incomplete
Light area above lateral stripe on caudal peduncle	Absent	Present; extends for one-and-a-half scales above lateral-line scales
Nuptial tubercles	Granular; very small; present in all individuals examined, regardless of sex or size (at least as small as 28 mm.)	Granular, but larger than in *N. semperasper*; present only in adult males
Lateral-line scales	37 to 43 (usually 38 to 41)	34 to 38
Predorsal scales	18 to 27 (usually 19 to 23)	14 to 19 (usually 15 to 18)
Maximum size	Smaller; largest specimen examined 62 mm. in standard length	Larger; largest specimen examined 73 mm. in standard length

TABLE 2. COMPARISON OF DISTINGUISHING CHARACTERS IN *Notropis semperasper* AND *Notropis amoenus*

Character	*Notropis semperasper*	*Notropis amoenus*
Pigmentation on underside of head	Not extending in streak down gular membrane	Extending in streak down gular membrane
Pigmentation on lips	Light	Dark
Position of dorsal fin	More anterior	More posterior
Nuptial tubercles	Present at all sizes	Present only in large breeding males
Size of eye	Larger	Smaller
Width of upper lip	Narrower	Wider
Gape of mouth	Wider	Narrower
Angle of symphysis of lower jaw	"U" shaped when viewed from below	"V" shaped when viewed from below
Lateral-line scales	37 to 43 (usually 38 to 41)	36 to 40 (usually 37 to 39)
Predorsal scales	18 to 27 (usually 19 to 23)	20 to 30 (usually 20 to 25)
Caudal peduncle scales	12 to 14 (average 13)	13 to 15 (usually 14)

of orbit; snout moderately pointed; scales of typical cyprinid shape, only slightly higher than wide; origin of dorsal fin slightly posterior to insertion of pelvic; dorsal fin pointed at tip; first developed ray of dorsal fin, when depressed, extending beyond last ray; tip of depressed dorsal fin reaching about halfway along base of anal fin; dorsal and anal fins notably falcate.

Nuptial tubercles evenly distributed, in no apparent pattern, over entire upper surface of head, preorbital area, lower part of cheek (sparse or absent in region immediately beneath eye), and down length of mandible; tubercles also present on gular membrane and branchiostegals, although often not particularly well developed or numerous on these surfaces; entire postorbital region devoid of tubercles, except for a very few which are occasionally present on lower part of opercle; tiny, almost invisible, tubercles present on upper surfaces of the outer pectoral rays in males only, this apparently being the only region of the body in which tubercles are present in one sex and not the other.

Distribution of circumferential scales above and below lateral line 13–2–11 (12), 13–2–12 (6), 13–2–13 (1), 14–2–11 (9), 12–2–12 (9), 14–2–13 (3), 15–2–11 (4), 15–2–12 (9), 15–2–13 (4), 15–2–14 (1); caudal peduncle scales (counted at level of third scale from end of lateral-line scale row) 12 to 14, usually 13;

number of pharyngeal teeth in outer row somewhat variable: 2,4–4,2 (9), 2,4–4,1 (1), 1,4–4,2 (2), 1,4–4,1 (1).

Dark pigment present on both lips, being particularly heavy on upper lip, and not quite reaching corners of mouth; top of head uniformly covered with small black melanophores, these extending down along side of snout, forming a narrow dark border around ventral and posterior parts of orbit; dark pigment absent from operculum, lower part of cheek, branchiostegals, and from most of gular membrane; small flecks of pigment along edges of pectoral, dorsal and caudal fin

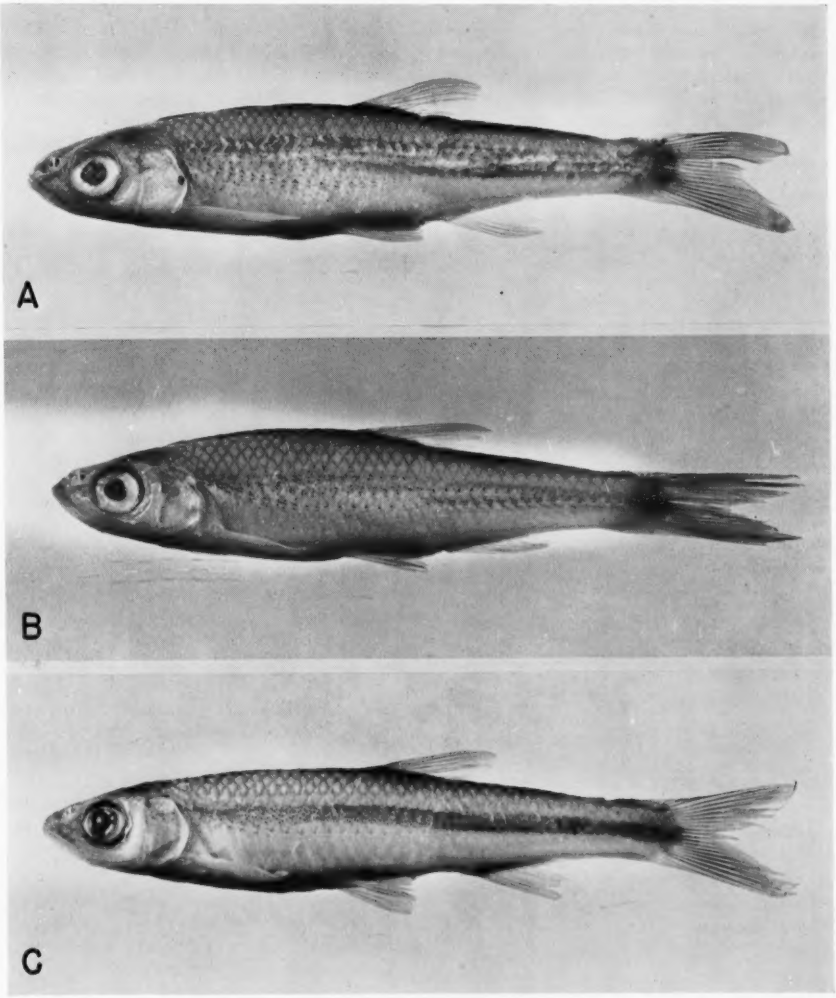

Fig. 1. *Notropis semperasper*, new species, compared with closely related forms.

Fig. 1A. *Notropis semperasper*, UMMZ 175100, adult female, 57.5 mm, from Potts Creek, near outskirts of Covington, Alleghany County, Virginia. (Dark spot on opercle is due to parasitism).

Fig. 1B. *Notropis scepticus*, UMMZ 175566, subadult male, 52 mm, from headwaters of Catawba River, 0.2 mi. S of Old Fort, McDowell County, North Carolina.

Fig. 1C. *Notropis amoenus*, USNM 191034, subadult, 52 mm, from Contentnea Creek, ca. 3 mi. SW of Wilson, Wilson County, North Carolina.

rays, absent from middle of fin membranes; small melanophores sparingly scattered over cleithral area as far ventrally as insertion of pectoral fin; scapular bar absent; scales along dorso-lateral part of back narrowly but distinctly edged with concentrations of black pigment, causing each scale to be clearly delineated; predorsal stripe irregular in width, narrow, and dark, but not particularly well defined, the stripe composed of numerous, relatively large melanophores which grade fairly abruptly into the smaller melanophores on either side; postdorsal stripe also dark and irregular, but slightly wider and better defined than predorsal stripe; overall aspect of fish dull silvery, or plumbeous, in life, with dorso-lateral part of back light gray; silvery area of pigmentation along side of body sharply delimited dorsally, especially in life, by a narrow stripe which is somewhat darker than the rest of the lateral stripe; upper margin of lateral stripe straight, extending from the level of the upper apex of the opercular connection posteriorly to the upper margin of the third scale row above the lateral line (in region directly below origin of dorsal fin) and to the middle of the first scale row above the lateral line on the caudal peduncle; silvery pigment evenly distributed above and below lateral line on

TABLE 3. COMPARISON OF VARIOUS SCALE AND FIN-RAY COUNTS IN *Notropis semperasper*, *Notropis scepticus*, AND *Notropis amoenus*

	Lateral-line scales										No.	Mean
	34	35	36	37	38	39	40	41	42	43		
Notropis semperasper	—	—	—	1	7	16	19	8	2	1	54	39.7
Notropis scepticus	4	11	18	4	3	—	—	—	—	—	40	35.8
Notropis amoenus	—	—	2	11	14	11	2	—	—	—	40	38.0

	Predorsal scales																	
	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Notropis semperasper[1]	—	—	—	—	1	3	11	15	12	10	2	1	—	1	—	—	—	56	21.5
Notropis scepticus	1	6	14	7	9	3	—	—	—	—	—	—	—	—	—	—	—	40	16.7
Notropis amoenus	—	—	—	—	—	—	6	7	4	5	6	8	1	1	—	1	1	40	23.2

	Circumferential scales								
	25	26	27	28	29	30	31		
Notropis semperasper	—	12	15	14	12	4	1	58	27.7
Notropis scepticus	3	18	15	3	1	—	—	40	26.5
Notropis amoenus	2	2	11	19	3	2	1	40	27.7

	Caudal peduncle scales					
	12	13	14	15		
Notropis semperasper	7	19	8	—	34	13.0
Notropis scepticus	11	9	—	—	20	12.5
Notropis amoenus	—	1	16	4	21	14.2

	Anal rays					
	9	10	11	12		
Notropis semperasper	—	40	18	—	58	10.3
Notropis scepticus	2	35	3	—	40	10.0
Notropis amoenus	—	16	29	3	48	10.7

[1] One specimen of *Notrobis semperasber* with a partial naked nape, is not included.

caudal peduncle, extending approximately one scale row above and below this line; widely scattered, small, black melanophores extending below the lateral line from just back of the head to about midway beneath the dorsal fin.

Relationships.—Although *Notropis semperasper* has, in the past, been referred to as *N. amoenus* (Fowler, 1922:9; Fowler, 1923:11; Raney, 1950:164–5), its closest relative appears to be *Notropis scepticus*, a fish of the southern piedmont area that occurs from the Cape Fear to the Santee systems (Hubbs, 1941:167). It is not yet certain to which species *N. semperasper* and *N. scepticus* are related, although Hubbs (op. cit.) compared *N. altipinnis* with the latter species and suggested a possible close relationship. It is also possible that *Notropis scabriceps*, an endemic species of the upper Kanawha River system, which is characterized by 2,4–4,2 pharyngeal teeth, eight anal rays, and the presence of nuptial tubercles in all but the smallest individuals, may be rather closely related. Except for the similarity in development of the nuptial tubercles, however, the overall aspect of *N. scabriceps* and *N. semperasper* seems to indicate that the relationship of these two species is not particularly close. The closest relatives of *N. scabriceps* may instead be such species as *N. blennius, N. volucellus* and *N. stramineus.*

Notropis semperasper is very similar in overall appearance to *Notropis scepticus* (see Figs. 1A and B), both species having an identical black-speckled peritoneum and similar fin ray and pharyngeal tooth counts. *N. semperasper*, however, differs as noted in the diagnosis and in Tables 1 and 3. In addition, the two species show a number of differences in proportional measurements; these appear in Table 4.

The relationship between *Notropis semperapser* and *Notropis amoenus* is less intimate than the preceding. *Notropis amoenus* is closely related to such species as *N. rubellus, N. photogenis* and *N. atherinoides*, all of which have 2,4–4,2 pharyngeal teeth and 10 or 11 anal rays. The combination of the above counts, which, in the past, has caused *N. semperasper* to be confused with *N. amoenus*, is also found in a number of other species of *Notropis* which are not closely related to either *semperasper* or *amoenus*. The latter two species are compared in Tables 2, 3 and 4.

Zoögeography.—The geographical distribution of *Notropis semperasper* presents a unique and puzzling problem. The James River system, to which *semperasper* apparently is restricted, contains only one other known endemic species of fish, *Etheostoma longimanum*, although an undescribed subspecies of *Etheostoma nigrum* is also present (Cole, 1957). The catostomid fish, *Moxo-*

TABLE 4. COMPARISON OF PROPORTIONAL MEASUREMENTS (EXPRESSED IN THOUSANDTHS OF STANDARD LENGTH) FOR *Notropis semperasper*, *N. scepticus*, AND *N. amoenus*[1]

	N. scepticus	*N. semperasper*	*N. amoenus*
No. of specimens	20	20	20
Size in mm.	52–70	48.5–62	48–68
	58	53	58
Predorsal length	496–535	514–557	534–569
	515	532	550
Dorsal origin to base of tail	483–520	466–514	442–486
	504	484	462
Prepelvic length	476–509	468–510	460–514
	490	492	483
Preanal length	648–691	633–680	648–687
	667	661	667
Head length	261–293	248–272	242–279
	275	263	255
Head depth	160–187	157–172	147–169
	173	163	159
Snout length	71–86	68–77	70–86
	78	73	76
Orbit length	87–103	389–100	74–97
	95	94	86
Mouth gape	61–79	62–69	49–57
	71	65	53
Length of lower jaw	109–135	101–122	109–126
	123	112	116
Greatest body depth	211–252	189–237	183–235
	230	204	202
Dorsal origin to lateral line	136–174	129–149	127–160
	156	138	140
Greatest body width	133–150	126–159	105–139
	141	138	126
Caudal peduncle length	171–200	182–210	160–198
	188	195	179
Caudal peduncle depth	95–114	91–100	90–114
	105	95	100
Length of depressed dorsal fin	222–260	209–246	199–224
	241	223	216
Length of pectoral fin	181–216	186–233	160–205
	199	206	188
Length of pelvic fin	156–175	153–170	140–170
	166	161	155
Length of anal fin	200–238	200–235	197–233
	224	217	215

[1] Under each series there is given, for each character, the range of variation, and, below, the average.

stoma rhothoecum, may also be considered endemic to this drainage, since its presence in both the New and Potomac basins probably is the result of relatively recent headwater captures. In contrast to *N. semperasper,* however, all three of the above have companion forms in the adjacent Roanoke system (*E. podostemone, E. nigrum* subsp., and *M. hamiltoni,* respectively). Thus, each of these pairs may be considered to have evolved from a single parental form which reached the James and Roanoke systems at about the same time, geologically speaking, most likely from the preglacial Teays system, the upper part of which occupied virtually the same channel as the present-day New River.

Since *Notropis semperasper* has no close relative in the Roanoke system, it can be surmised that the history of distribution of this species is different from the other James endemics, or near endemics, It appears that the distribution of the *semperasper-scepticus* precursor extended at least from the Santee to the James. For reasons unknown, that segment of the population which occupied the present Roanoke basin became extirpated, possibly prior to the Pleistocene, and the geographically isolated populations to the north and south subsequently evolved into distinct species.

Ecology.—*Notropis semperasper* lives in or near the clear, swift, gravel or rubble-bottomed riffles which are characteristic of tributaries of the upper James River. It often is found with *Notropis rubellus,* and thus presumably occupies a habitat similar to that species. *N. semperasper* apparently spawns in late April or early May, as evidenced by the collection of a gravid female (USNM 162868) on April 27, 1952.

Etymology.—The name *semperasper,* which was first suggested by Dr. Hubbs, is derived from the latin adjectives *semper* (always) and *asper* (rough), in reference to the granular nuptial tubercles which were present even in the smallest individuals examined.

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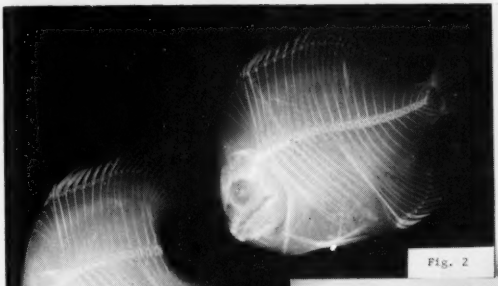
Some Fishes that Survive Extreme Injuries, and Some Aspects of Tenacity of Life

Gordon Gunter and J. W. Ward

Fishes that survive extensive injuries from the attacks of predators are observed from time to time by workers handling large numbers of specimens, but accounts of such cases are few. During the past few years the first author collected injured marine fishes from the Louisiana and Mississippi coasts, which are herewith described. Abbreviations used are: H. L. = head length, S. L. = standard length, B. L. = body length; T. L. = total length. Some of the biological implications of injured fishes are discussed.

Specimen I and II.—Spadefishes, *Chaetodipterus faber,* with a large part of the vertebral column missing. I—B. L. = 12.0 cm.; II—B. L. = 11.5 cm. (Figs. 3 and 4).

A photograph and X ray photograph of a normal spadefish with 23 vertebrae may be seen in Fig. 1 and 2. It contrasts sharply with specimen I that recovered from the loss of a large part of its posterior end, which was apparently bitten off. This specimen has only 12.5 vertebrae. The tail, caudal peduncle and part of the trunk are gone. The wounded animal has two tails more or less, formed by parts of fins, which lack rigid support and are



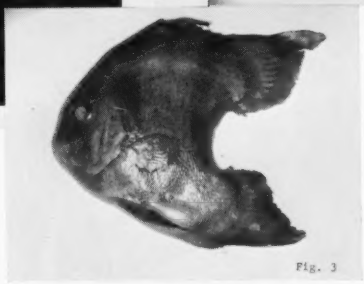


Fig. 1. Photograph of a spadefish, *Chaetodipterus faber*.
Fig. 2. X ray photograph of fish in Fig. 1.
Fig. 3. Photograph of an injured spadefish.
Fig. 4. X ray photograph of specimen shown in Fig. 3. Figs. 1–4 are all the same scale.

doubtless quite inefficient. The fish was caught on the beach at Biloxi, Mississippi in 1956.

Specimen II is a replica of specimen I in size and type of injury. An X ray shows that the vertebral column was apparently bitten off at about the 12th vertebra. The fish was caught in a trawl off Grand Isle, Louisiana by C. E. Dawson on October 30, 1959 in 7.5 fathoms of water.

Mr. William Haskell, of the U. S. Fish and Wildlife Service, Pascagoula, Mississippi, loaned us another spadefish similar in size to the other two and with an almost identical injury. It was trawled off Wine Island, Louisiana by the boat "Terry Ann" in 6–8 fathoms of water on June 14, 1960. It was 7.0 cm. long from the head to middle of the decaudate region. The greatest horizontal length, measured to the tip of the dorsal fin extended posteriorly, was 12.5 cm. An uninjured fish of the same size was 14.0 cm. long. The acquisition of this third specimen indicates that injury of the type shown in Fig. 3 and 4 is not an extreme rarity among spadefish.

Specimens III, IV and V.—Croakers, *Micropogon undulatus*, with the tail and caudal peduncle missing. III—H. L. = 37 mm, T. L. = 87 mm; IV—H. L. = 46, T. L. = 109; and V—H. L. = 49, T. L. = 115. (Fig. 5 and 6).

Three similarly injured croakers in the Gulf Coast Research Laboratory collection have had the whole tail and caudal peduncle chopped off at the posterior end of the soft dorsal fin. They were taken in trawls in Biloxi Bay and Mississippi Sound between January 1957 and 1959. The wounds are healed and grown over with scales, as shown for the larger specimen in Fig. 5 and 6. The soft dorsal rays have grown down over the stump to the lateral line; the posterior rays point downward, and the fish has virtually developed another caudal fin, although an inefficient one. Whereas the posterior rays of the soft dorsal are smaller than the more anterior rays in normal fish, in the injured fish the posterior rays have grown larger and longer than normal, as has been reported by Breder (1953) in other species. The normal number of soft dorsal rays in croakers is 27 to 29, and in the three injured fish two of the counts are 27 and one is 28. Probably the soft dorsal was not involved in the injury.

Specimen VI.—A mullet, *Mugil cephalus*,

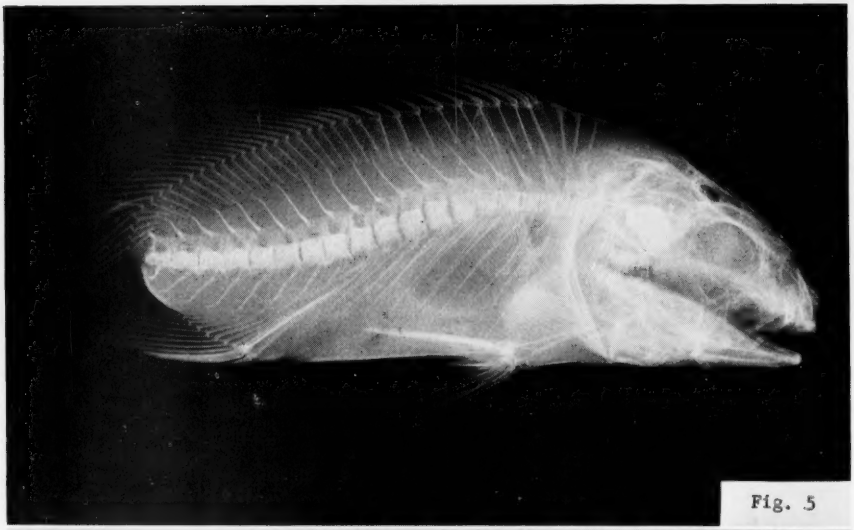


Fig. 5

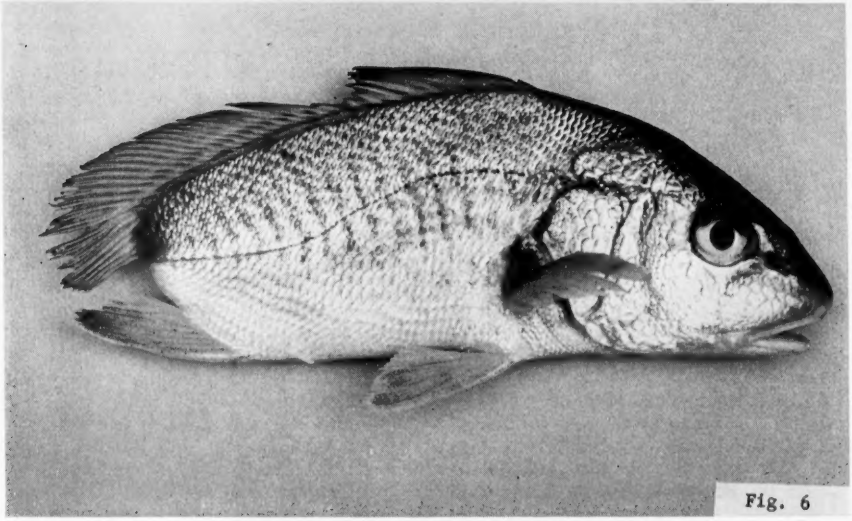


Fig. 6

Fig. 5. X ray photograph of a decaudate croaker, *Micropogon undulatus*.
Fig. 6. Photograph of the specimen shown in Fig. 5.

lacking a tail fin, taken in Biloxi Bay in 1958. VI—H. L. = 6.7 cm., T. L. = 24.7 cm. Most of the caudal peduncle of this fish remains, but the tail fin is missing. The wound is entirely healed and grown over with scales.

On February 19, 1958 three injured Gulf menhaden, *Brevoortia patronus*, were taken by J. Y. Christmas in one set of a gillnet in the small craft harbor of Pascagoula, Mississippi. One fish, 17.8 cm. in standard length, shows scars and a wound of the caudal peduncle of a relatively superficial nature. The other two fish described below are of more interest because of the greater damage they suffered.

Specimen VII.—A menhaden, *Brevoortia patronus*, with a wound in the back. VII—S. L. = 18.5 cm. (Fig. 8 and 10). The wound

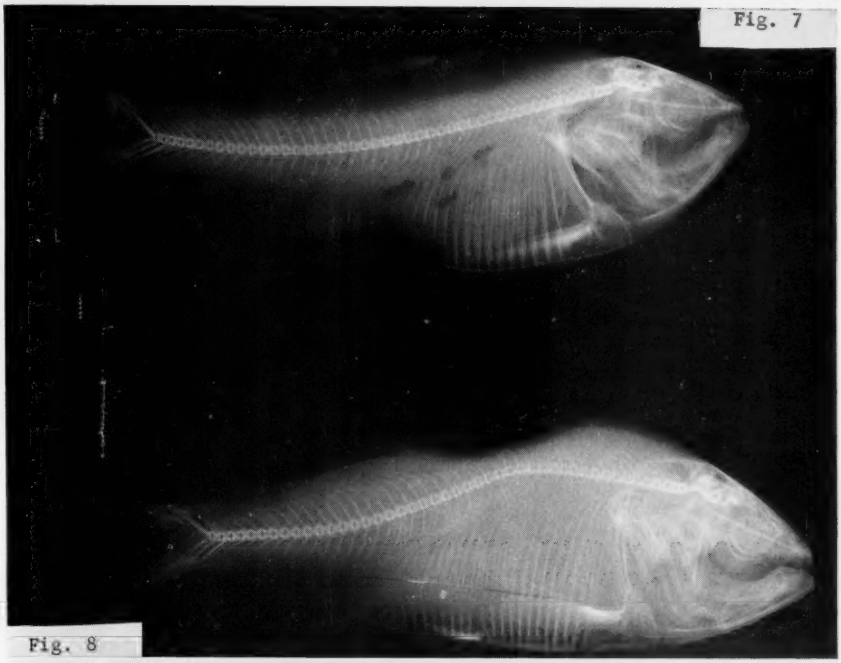


Fig. 9

Fig. 7. X ray photograph of a menhaden, *Brevoortia patronus*, with a lunate area bitten out of the abdomen.
Fig. 8. X ray photograph of a menhaden with a lunate area bitten out of the back.
Fig. 9. Photograph of the same specimen shown in Fig. 7.
Fig. 10. Photograph of the same specimen shown in Fig. 8.

reaches from the operculum almost to the tip of the pelvic fins, being 5.0 cm. long and 2.0 cm. across at its greatest width, with a total area of approximately 8.0 square cm. The wound, with a somewhat raw appearance, is healed over with scaleless skin, but the fish is not emaciated. In silhouette the lesion is sickle-shaped, and probing shows that at its deepest part the surface is only about 3 mm. from the spinal column. The injury apparently weakened the support of the spinal column so that a downward flexure of the column developed.

Specimen VIII.—A menhaden, *Brevoortia patronus*, with a half-moon area bitten out of the abdomen. VIII—S. L. = 19.0 cm. (Fig. 7 and 9). It recovered in part from what is probably the most serious injury to fishes considered in this account (Fig. 7 and 9). Some predator had bitten a lunate area out of the abdominal region just in front of the anus. The wound is 35 mm. long and 12 mm. deep. There are three pre-anal scutes remaining between the anus and the posterior border of the lesion, and 18 scutes in front of it. About ten ventral scutes and the pelvic fins are missing. The lesion is covered with a thin, almost membraneous layer of skin and flesh, devoid of scales. The wound is not completely closed, and in its center there is an oblong hole 2 by 3.5 mm. The fish is emaciated and, presumably, it did not grow after being hurt, suggesting that the wound has remained approximately the same size.

Fig. 11. Photograph of a seahorse, *Hippocampus erectus*, with the tail gone.

Specimen IX.—A female seahorse, *Hippocampus erectus*, with the tail missing (Fig. 11), taken in Lemon Bay, Florida on January 4, 1959 by M. K. Chadwick. We are indebted to Dr. Eugenie Clark of the Cape Haze Marine Laboratory, Placida, Florida, for the specimen. She informed us that the fish lived in her laboratory from January 4 to March 17, where it swam at an angle of about 45° and frequently rested on the bottom. The full complement of 21 rays are present in the dorsal fin and all four anal rays are present. The fish is cut off at the base of the trunk, no caudal segments being present. With no tail to curl around linear objects, it modified its behavior, as Doctor Clark indicated, and rested on the bottom. The lack of a tail to balance the head pulled the fish forward at an angle when it swam.

Discussion

Gunter (1945) reported four cutlass fish, *Trichiurus lepturus*, with parts of their tails cut off and healed. One fish had lost more than 47 percent of its length. Breder (1953) gave an account of a goldfish that lost its caudal region in a pond where healing could be observed. He also cited 11 reports on nine other species of fishes which survived loss of of the tail and caudal trunk. Three species (Hofer, 1901, Breder, 1934, Pope, 1945) had suffered extreme injuries, comparable to Breder's goldfish and the spadefish reported in this paper. The present report and Gunter (*op. cit.*) add three more species to the list of decaudate fishes. Breder noted that the phylogenetic spread of decaudate fishes does not indicate that any one group is more likely to suffer such accidents than another, but as he noted, it is inconceivable that such delicate fishes as anchovies would survive loss of the tail. In fact, it is almost incredible that any fish can survive the wounds from which some of them recover. Dr. H. J. Bennett told us of a white squeteague, *Cynoscion arenarius*, he caught which had so much of the tail and caudal region gone that it could no longer swim horizontally; instead it went around with its head up, propelling itself by the dorsal fins in the manner of seahorses.

There are many indications ranging from attacks of sharks on human beings to observations on smaller predatory fish, that the predator often makes one pass and goes his

way without doggedly concentrating upon a single individual. (The faster hawks and the falcons have similar habits.) This habit of predators probably permits the handicapped fish to survive for a time. Furthermore, not all wounded fish are entirely helpless. Breder first thought to remove his wounded goldfish from the pool and destroy it, but it wiggled so vigorously that it could not be caught easily.

Critically wounded fish face several major problems. First they must stanch the flow of blood. Obviously the blood of fishes clots very quickly, as shown by the gross wounds they survive. Sulya *et al.* (in press), experienced considerable difficulty in keeping fish blood in a state of liquefaction. Wounded fishes must also overcome osmotic disturbances entailed by loss of body mucus and skin, prevent infection, and avoid enemies, and slow healing individuals must gain enough food to permit healing. Coagulation of the blood, osmotic adjustments, healing and resistance to infection are certainly involuntary reactions in fishes not influenced by emotion. Possibly, fishes accomplish some of these ends by going into shallow, warm waters for a period of recuperation. Old commercial fishermen of the Texas coast have told the first author that ill or injured fishes come in to shallow water during periods of debility.

A fish which survives a gross wound resulting in the loss of a large part of its body and great changes in its ability to swim, with concomitant major changes of habits such as food getting and avoidance of enemies, appears to have a great tenacity for life and a strong will to live. Such a will or desire may exist, but it may be an illusion and we are not logically permitted to invoke it until simpler explanations can be excluded.

Breder's (*op. cit.*) wounded goldfish avoided the other fishes, and may have been avoided in turn, possibly due to some chemical reaction. In schooling fishes the reaction would seem not to have survival value, unless the fish abandoned the school entirely and sought some retreat inshore or elsewhere, for a wounded fish trailing along on the outskirts of a school would be in a dangerous position. Breder also observed that his wounded goldfish sloughed off its necrotic tissue and was freshly healed in five days at water temperatures of 18–23° C. That is a significant observation for it indicates that fishes, presumably well-fed, can heal before they must undertake feeding activity. A croaker, *Micropogon undulatus*, brought into our laboratory on July 22, 1960 had a gash on one side into the abdominal cavity. It was fed on shrimp. In a week's time the wound completely healed.

Wounded fishes that recover are probably quiescent for a few days, during which time the wound heals and the necrotic tissue sloughs off. The removal of a large part of the post-coelomic region of a fish by predators results at times in a stump-tailed condition, not much worse for the wear except that it cannot swim well. The fish is vulnerable on two points, food gathering and the avoidance of enemies. Loss of the tail in plankton feeders (menhaden) or speedy, predatory fishes (mackerels) would seem to be a grave handicap resulting in slow starvation, and no such fishes have been reported. On the other hand, certain predatory fish, such as Doctor Bennett's squeteague (see above) and red drums without eyes (Gunter, 1956) seem to be able to gather food and remain fat. These blind fish probably do not have to learn new feeding habits, because redfish are known to feed on the darkest nights; probably such fish are forced to emphasize certain former feeding habits while abandoning others.

A healed fish presumably becomes more active and begins to search for food. It cannot swim well, but it may find food and may even become fat. Thus a fish which undergoes terrible, maiming wounds recovers, readjusts its life in some ways and continues to live. The fact that fishes may lack various psychic attributes give them a strong hold on life in cases of extreme adversity, because they are probably spared psychic shock and trauma. The animals appears to have a strong will to live, but this is probably an illusion, produced by a concatenated series of involuntary events each automatically leading to the next one, i.e., blood loss and coagulation, osmotic adjustments, necrosis, healing and hunger.

On the other hand it is quite proper to say that some fishes have great tenacity of life, because the term has no intrinsic emotional implications and is simply a statement of fact. In any case, many fishes survive great wounds without care or attention, and such survival is without parallel in the other vertebrates.

The survival in nature of grossly wounded individuals shows that fishes do not live in a knife-edged, unalterable relationship with the environment. Fishes have broad basal re-

lationships with the environment and when part of this relation is abruptly obliterated the remainder sometimes suffices to maintain life. Better understanding of that situation would throw some light upon the non-lethal limits of variation of harmful hereditary and morphogenetic processes.

The second author was enabled to work on this project by a grant of the National Science Foundation for "Summer Research at the Gulf Coast Research Laboratory" during the year 1959.

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Gulf Coast Research Laboratory, Ocean Springs, Mississippi and Department of Anatomy, University of Mississippi Medical Center, Jackson.

Comparison of *Hybognathus hayi* Jordan and *Hybognathus nuchalis* Agassiz[1]

Sue Whitsell Fingerman and Royal D. Suttkus

THE comparative study of *Hybognathus hayi* Jordan, 1885, cypress minnow, and *Hybognathus nuchalis* Agassiz, 1855, silvery minnow, was done to determine distinguishing features of the two species. They are frequently confused because the differences are not easily recognized. Both forms are abundant in the Pearl River where the material for this study was obtained. The site of collection of most of the material is approximately 90 airline miles downstream from Jackson, Mississippi, the type locality of *H. hayi*.

Materials and Methods

The material used in this study is deposited in the Tulane University fish collection, the United States National Museum and Museum of Comparative Zoölogy. The authors wish to thank Myvanwy Dick for help in making specimens available for study and Robert H. Gibbs, Jr., for measurements of types of *H. nuchalis* in the Museum of Comparative Zoölogy and Ernest A. Lachner for the loan of material from the U. S. National Museum. The number of specimens and range of standard length in millimeters for each collection are indicated below in parentheses, e.g. (5, 25–42). The figures enclosed in parentheses in other sections of the paper are averages. Counts and measurements were taken according to the methods described by Hubbs and Lagler (1947:8–15). X ray photographs were used for the enumeration of vertebrae. The counts were not made for lectotypes.

Hybognathus hayi—the 76.2 mm. specimen of the type series, USNM 32306, is hereby designated as lectotype, the remaining specimens (9, 33–81) are recataloged, USNM 195573. Other material: TU 7323 (6, 83–94), La., Washington Par., pool near Pushepatapa Cr., 1 mi. S Varnado; TU 7259 (15, 51–92), TU 7303 (163, 47–89) and TU 13292 (12, 39–45), Miss., Marion Co., Pearl R. 3 mi. NE Sandy Hook; TU 23291 (18, 40–89), Miss., Leake Co., Pearl R. 1 mi. S Carthage.

Hybognathus nuchalis—the 73.6 mm. specimen of the type series, MCZ 1926, is hereby designated as lectotype; the other specimens (10, 41–69) are recataloged, MCZ 40697. The catalog entry shows 20 as the original number of specimens in MCZ 1926. Agassiz (1855) did not state how many specimens were used in the orginal description. A label in the jar, MCZ 1926, has 15 specimens recorded.

[1] This study was supported in part by Grant No. RG-6279 (R1) from the National Institutes of Health.

Four of the fifteen were sent to the U. S. National Museum, USNM 120272 (4, 34–77). Another series (2, 70 and 72) MCZ 27435, is marked as types and was supposed to have been received from the Salem Museum, but according to a note by Carl L. Hubbs they were originally sent to that museum from the Museum of Comparative Zoölogy. The latter two specimens could have been part of the original series thus leaving only three unaccounted for of the original 20 specimens. Other material: TU 1862 (646, 30–62), TU 7261 (167, 42–71), TU 8501 (172, 32–72) and TU 13286 (64, 32–65), Miss., Marion Co., Pearl R., 3 mi. E Sandy Hook; TU 23523 (36, 45–75), Miss., Copiah Co., Copiah Cr., 2.4 mi. S Georgetown, Hwy 27.

Diagnosis

Hybognathus nuchalis body shape is subterete; that of *hayi* is compressed. *Hybognathus hayi* has an angular profile; *nuchalis* is rounded.

The diamond pattern of *H. hayi* is striking and is similar to the body pigmentation of most members of the subgenus *Cyprinella* of the genus *Notropis*. The pattern of *H. nuchalis* is suggestive of "diamonds," but due to the more uniform pigmentation the diamond pattern is obliterated. Melanophores of the anterior part of the lateral band of *hayi* are small and only slightly larger than the melanophores on the upper part of the sides and back. However, the large melanophores of the anterior part of the lateral band of *nuchalis* are usually noticeably larger than the melanophores above the band. The median dorsal stripe in front of dorsal fin is wider and darker in *nuchalis*.

Hybognathus hayi has a much shorter intestine in proportion to the standard length than does *nuchalis*.

The snout is broadly rounded in *hayi* and can scarcely be seen from the ventral aspect. However the snout of *nuchalis* is more pointed and projects anteriorly beyond the upper lip by about twice the thickness of the upper lip.

Description

Hybognathus hayi—(Fig. 1, top) Fifty specimens in addition to the lectotype were used for the pharyngeal tooth, fin ray and scale counts. The counts of the lectotype are shown in bold face print. Pharyngeal teeth, 4–4 (one specimen of fifty has 4—5; the right arch has one tooth slightly hooked and firmly ankylosed behind the second tooth from the upper end of the arch. This additional tooth does not show any wear and has a slight concavity on the grinding surface). Anal rays **8**, caudal **19**, dorsal **8**, pectoral, left **16**—right **15**, 14–16 (15.1). Scales along the lateral line range, **38**, 34–41 (37.9); predorsal rows, **15**, 13–20 (14.8); body circumference scale rows above the lateral line **9–13** (11.4), below the lateral line, **13**, 10–15 (12.5), total, **28**, 23–30 (25.9); caudal peduncle scale rows above the lateral line **5–7** (6.2), below the lateral line, **6**, 5–7 (5.8), total, **15**, 12–16 (14.2). Vertebrae were counted from 47 specimens. Caudal vertebrae 17–19 (17.8), precaudal 20, total 37–39 (37.9).

The anal and pelvic fins usually lack pigmentation. The lower principal ray as well as the lower procurrent rays of the caudal fin is devoid of pigment thus making a light margin on the fin. This pigmentation is not unique to the silvery minnow. The contrasting light margin on the caudal fin is present in other forms such as *Hybopsis storeriana* and several suckers, notably *Moxostoma poecilurum* which has dense pigmentation on several rays immediately above the light margin. The other principal rays and the upper procurrent rays have their upper and lower margins pigmented. In addition there are scattered melanophores on the lateral surfaces of the rays. The anterior six or seven rays of the pectoral fins have their posterior margins, and occasionally anterior margins, pigmented. The more posterior rays are progressively less pigmented than the anteriormost. The dorsal fin has melanophores along the anterior and posterior borders of all the rays and occasionally there are melanophores on the rays. Heavy pigmentation along the base of the dorsal fin extends upon the bases of the rays and upon the interradial areas. A few melanophores are present along the base of the anal fin and there is a continuation of melanophores from the posterior base of the anal fin to the base of the caudal fin forming a weak, postanal stripe. Moderately heavy pigmentation on the upper half of the opercle and preopercle extends around the eye covering the interorbital area, occiput, snout, upper lip and the area under the lower lip. A narrow median dorsal stripe extends from the occiput to and around the base of the dorsal fin, and to the base of the procurrent rays of the caudal fin. This median dorsal

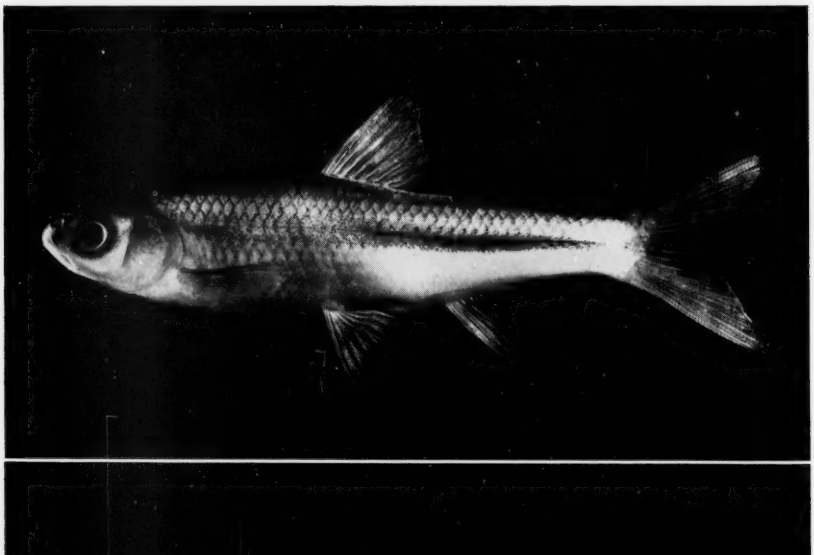

Fig. 1. Top: *Hybognathus hayi* Jordan, TU 16182, Miss., Marion Co., Pearl R. 2.3 mi. NE Sandy Hook, 7 August 1957, (79 specimens in series). Bottom: *Hybognathus nuchalis* Agassiz, TU 16183, same as above, (213 specimens in series).

stripe is more pronounced posterior to the dorsal fin. There is moderately heavy pigmentation over the entire back; melanophores are concentrated on the margins of the scales forming an obvious diamond-shaped pattern. The lateral band, of medium size melanophores, extends from the operculum to the base of the caudal fin. Anteriorly, most of the band is dorsal to the lateral line and covers the row of scales above the lateral line row. The posterior part of the band is narrower and continues along the lateral line system to the base of the caudal fin. Some specimens have a few melanophores below the lateral band in the posterior region. The slight broadening of the posterior termination of the lateral band forms a blotch. Melanophores of the lateral band are scattered over the entire scale. Anteriorly, pigmentation below the lateral band extends onto the row of scales below the lateral line as far posteriorly as the origin of the pelvic fins. Above the lateral band the pigmentation is continuous with pigmentation on the dorsal surface.

Hybognathus nuchalis—(Fig. 1, bottom) Fifty specimens in addition to the lectotype were used for pharyngeal tooth, fin ray and

scale counts. Pharyngeal teeth, 4–4. Anal rays **8**, caudal **19**, dorsal **8**, pelvic **8** and pectoral **15**–16 (15.4). Scales along the lateral line, **37**, 31–44 (38.0); predorsal rows, **15**, 13–18 (14.8); body circumference scale rows above the lateral line, **11**, 9–13 (11.6), below the lateral line, **12**, 11–15 (12.8), total **25**, 22–31 (26.4); and caudal peduncle rows above the lateral line, **7**, 5–8 (6.5), below the lateral line, **5**, 4–7 (5.7), total, **14**, 11–17 (14.2). Vertebral counts were made from 100 specimens: caudal vertebrae 16 or 17 (16.9), precaudal 20, total 36 or 37 (36.9).

Pigmentation of the fins is essentially the same as that of *H. hayi*. The light margin of the caudal fin is less marked because most specimens have some pigment along the lower principal ray and a few have some melanophores on the margins of the lower procurrent rays. There is less pigmentation at the base of the dorsal fin and very little extends onto the rays. But the pigmentation does extend farther onto the basal portion of the interradial membranes. The amount of pigmentation around the anal fin and posterior to it is variable. Some specimens are without pigment around the anal fin, but others have scattered melanophores along the base of the anal and posterior to it. Pigmentation on the head is essentially the same as *hayi*. The median dorsal stripe is wider and darker on *nuchalis* than on *hayi*, especially that part anterior to the dorsal fin. Anteriorly, the lateral band is approximately three scale rows deep and the major portion of it is above the lateral line. The posterior part of the band is narrower and extends along the lateral line. There are usually many melanophores ventral to the lateral band, sometimes extending from the base of the anal fin to the ventral surface of the caudal peduncle. The melanophores of the lateral band are usually larger than those above the band.

Hybognathus hayi has a more anteriorly placed dorsal fin than does *nuchalis*; the dorsal origin to caudal base distance (expressed in thousandths of standard length) has a range of 518–562 (540.3) in *hayi* and 494–548 (521.0) in *nuchalis*. The pelvic fin is more anteriorly placed in *hayi* which has a pelvic insertion to snout measurement of 464–513 (487.9); *nuchalis* has 499–543 (520.0). The anal origin to caudal base measurement indicates that *hayi* has a more anteriorly placed anal fin, 299–342 (318.0) and *nuchalis* 248–294 (273.5). *Hybognathus hayi* has a longer caudal peduncle, 184–233 (210.4) than *nuchalis* 166–207 (187.5). The head width of *hayi* is 108–127 (115.7); *nuchalis* 123–135 (127.6). *Hybognathus hayi* has a shorter snout 63–77 (68.2) than *nuchalis* 70–90 (79.0). The suborbital, least width of *hayi* 20–32 (25.8) is less than *nuchalis* 30–42 (35.4). The anal fin depressed length of *hayi* is 160–204 (181.7); *nuchalis* 148–180 (164.5). A complete tabulation of numerical values are presented in Table 1.

The gut tract measurements of three fresh and seven preserved specimens of each species indicate that *hayi* has a much shorter gut tract in proportion to the standard length than *nuchalis* and this substantiates Hay's observations as reported by Jordan (1885: 549). In the three fresh specimens of *hayi* the gut tracts were 4.8, 5.6, and 5.7 (5.3) times the standard length; whereas in *nuchalis* the gut tracts were 7.3, 8.1, and 9.5 (8.3) times the standard length. In the seven preserved specimens of *hayi* the gut tracts were 4.8, 5.4, 5.8, 5.8, 5.9, 6.2 and 6.5 (5.6) times the standard length; whereas in *nuchalis* they were 7.9, 8.4, 8.4, 8.6, 9.4, 11.4 and 11.5 (9.2) times the standard length.

Color in Life

The belly and sides of *H. hayi* are silvery. Anteriorly, the silvery area extends dorsad onto the row of scales above the lateral line row; posteriorly, the silvery color extends midway up the side of the peduncle and does not extend above the lateral line row of scales. The upper part is overlaid by a lead band which is more pronounced posteriorly on the caudal peduncle. Bordering the silvery area is a "high line" of iridescent green-gold. A median dorsal, green-gold stripe posterior to the dorsal fin extends to the upper procurrent rays of the caudal fin. Posterior to the eye on the upper anterior margin of the opercle and posterior margin of the preopercle is an iridescent green-gold spot. There is a blue-green crescent immediately above the opercular opening which curves dorsally and anteriorly. This crescent terminates above the junction of the upper part of the preopercle and opercle; anterior to this termination is a short gap and a continuation of a similar colored stripe. This latter stripe is wavy and extends to the dorsal rim of the orbit. There is a less intense green area on the occiput. The rest of the dorsal surface is dark olive-green.

The belly and sides of *H. nuchalis* are sil-

TABLE 1. PROPORTIONAL MEASUREMENTS OF ADULTS OF *Hybognathus hayi* AND *Hybognathus nuchalis*

All proportions are expressed in thousandths of the standard length.

Measurement	*Hybognathus hayi*			*Hybognathus nuchalis*		
	USNM 32306 Lectotype	50 Other specimens		MCZ 1926 Lectotype	50 Other specimens	
		Range	Average		Range	Average
Standard length (mm.)	76.2	50.5–92.7	67.0	73.6	49.4–70.8	56.0
Dorsal origin to snout	467	471–509	488.3	499	486–532	511.3
Dorsal origin to c. base	558	518–562	540.3	541	494–548	521.0
Dorsal origin to occiput	285	274–315	295.7	313	272–328	299.1
Pelvic insertion to snout	476	464–513	487.9	490	499–543	520.0
Anal origin to caudal base	340	299–342	318.0	287	248–294	273.5
Body:						
greatest depth	227	198–255	222.3	255	201–272	227.2
greatest width	100	102–139	119.0	131	116–199	131.7
Dorsal origin to lateral line	134	116–144	128.8	137	124–157	136.5
Pelvic insertion to lateral line	104	84–123	104.0	107	83–139	100.0
Caudal peduncle: length	229	184–233	210.4	190	166–207	187.5
least depth	101	83–100	90.9	111	95–114	101.4
Head:						
length	240	231–266	246.7	229	230–265	252.2
depth	148	141–166	148.9	156	148–170	158.3
width	119	108–127	115.7	126	123–135	127.6
Interorbital	88	78–100	93.5	—	84–100	90.7
Snout length	69	63–77	68.2	69	70–90	79.0
Eye length	60	52–74	61.0	62	56–71	63.5
Upper jaw length	63	48–63	55.8	57	51–66	59.1
Suborbital least width	27	20–32	25.8	31	30–42	35.4
Dorsal fin depressed length	240	218–280	241.3	211	213–283	237.0
Anal fin depressed length	185	160–204	181.7	164	148–180	164.5
Caudal fin, base to tip	—	282–346	305.7	—	276–326	303.2
Pectoral fin length	181	173–232	193.0	186	175–230	201.3
Pelvic fin length	177	158–194	174.8	153	140–176	161.5

very. Anteriorly, the silvery area extends dorsad onto one and a half rows of scales above the lateral line; posteriorly, the silvery area extends midway up the side of the peduncle and extends onto the scale row above the lateral line row of scales. An iridescent green-gold stripe borders the upper edge of the silvery area. A median, dorsal, iridescent, green-gold stripe is present anterior, as well as posterior, to the dorsal fin. The several fresh specimens of *hayi* examined did not have the green-gold stripe anterior to the dorsal fin and thus *hayi* may differ from *nuchalis* in this respect.

HABITAT

Hybognathus hayi appears to prefer quiet water over a soft bottom. The sample of July 24, 1956 was taken from a backwater lagoon covered by a bloom of algae. *Hybognathus nuchalis*, collected the same day were taken from a side pool (eddy current) of the main river; however a few were taken with *hayi* from the lagoon. *Hybognathus nuchalis* seem to prefer moderate current over a mud, sand or gravel bottom. Many additional collections of each species were obtained and invariably *hayi* were taken from still backwaters, and *nuchalis* usually from main stream in slow to moderate current. Apparently *nuchalis* is not as specific in its habitat requirements as *hayi*. These observations confirm the previously published data on the habitats of *hayi* and *nuchalis* (Forbes and Richardson, 1920:114–6; Kemp and Hubbs, 1954;113–4).

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Ichthyological Notes

OCCURRENCE OF EARLY DEVELOPMENTAL STAGES OF THE OBLONG OCEAN SUNFISH *RANZANIA LAEVIS* (PENNANT) IN THE CENTRAL NORTH PACIFIC.—Little has been reported concerning the morphology and distribution of the early developmental stages of the oblong ocean sunfish, *Ranzania laevis* (Pennant), in the central North Pacific. The only previous report is that of Jordan and Snyder (1901, *Proc. U. S. Nat. Mus. 24(1254):263*), who mention a 4-inch specimen (referred to as *R. makua*) collected at Honolulu but offer no additional information. Mention of adult oblong ocean sunfish occurrences in the central North Pacific, usually of single specimens collected from the immediate vicinity of Honolulu, are more numerous: Jenkins (1895, *Proc. Calif. Acad. Sci. 5:779–84*), reported a new species, *R. makua* Jenkins, collected from the vicinity of Pearl Harbor, Oahu; Fowler (1900, *Proc. Acad. Nat. Sci. Phila:514*), described a skin of *R. makua* collected by J. K. Townsend in Honolulu in 1835; Jordan and Evermann (1903, *Bull. U. S. Fish Comm. 23:440*), provided a redescription of the type specimen, *R. makua*; Gunther (1910, *J. Mus. Godeffroy 9(17):477*), reported a specimen of *R. truncata* collected from the Hawaiian Islands; Jordan and Jordan (1922, *Mem. Carnegie Mus. 10(1):89*), mention four *R. makua* collected from Honolulu; Fowler (1922, *Copeia 112:84*), listed *R. truncata* as present in the fish collection of the *Acad. Nat. Sci. Phila.*; Jordan, Evermann and Tanaka (1927, *Proc. Calif. Acad. Sci. 16(4): 680*), include *R. makua* in a list of fishes collected from the Hawaiian Islands; Fowler (1928, *Mem. Bishop Mus. 10:475*), reported the collection of single specimens of *R. truncata* on several occasions at Honolulu and later (1938, *Acad. Nat. Sci. Phila. Mon.*) included *R. truncata* in a list of fishes collected from Eastern Oceania.

This report is concerned with the morphology and distribution of early developmental stages of *R. laevis* from plankton samples in the collections of the Bureau of Commercial Fisheries Biological Laboratory, Honolulu, Hawaii (HBL).

A total of 1,531 identifiable young stages of *R. laevis* were separated from 98 plankton samples, of which 28 contained specimens, (Table 1). These plankton samples had been collected during 1959 as part of an oceanographic survey of Hawaiian waters, extending from 13° to 26°N. latitude and from 145° to 170° W. longitude (Fig. 1). All hauls were of 30 minutes duration and were taken at approximately 2100 hours using a 1-m net (aperture widths: belly section, 0.65 mm; rear section 0.3 mm) towed obliquely from 60 m to the surface, with the exception of two oblique tows from 140 m. An additional 1,084 *R. laevis* larvae were separated from plankton samples collected from an International Geophysical Year monitoring station located at 21°10′N. latitude, 158°19′W. longitude. The station was occupied at monthly intervals from July to December 1958 by HBL personnel. When conditions permitted, two evening and two daylight oblique tows from 60 m to the surface were taken with a 1-m net (aperture widths same as above). Of a total of 64 samples collected, only

Table 1. Seasonal Occurrence of *Ranzania laevis* Collected in 1959 on Oceanographic Surveys, 13° to 26°N., 145° to 170°W.

	Jan.–Feb.	March–April	May	July	Oct.
Number of plankton hauls	31	21	22	13	11
Number of hauls containing *R. laevis*	13	12	3	—	—
Total number of *R. laevis*	852	671	8	—	—

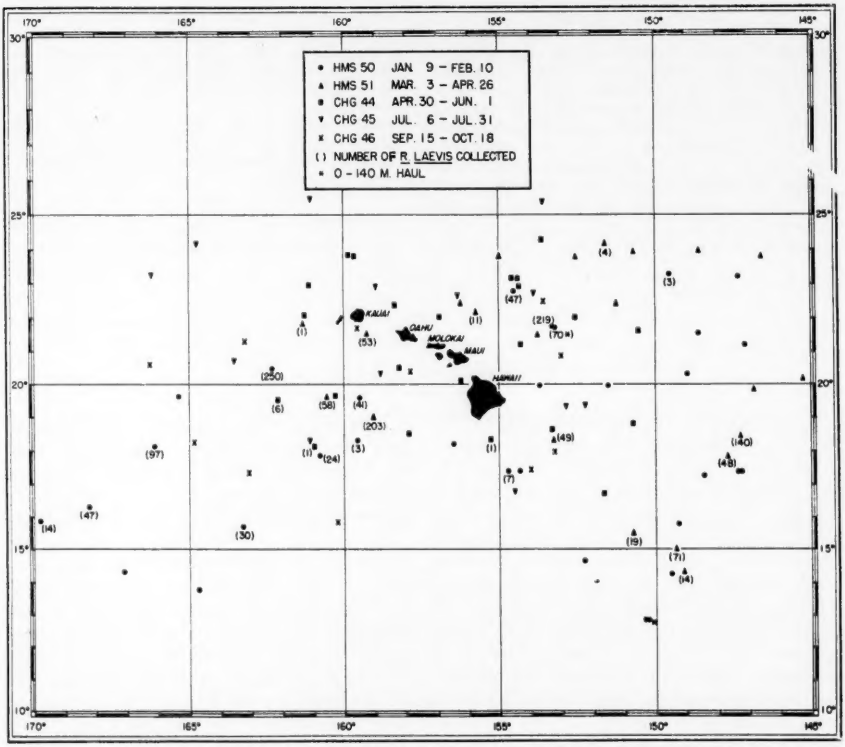

HMS 50 JAN. 9 – FEB. 10
HMS 51 MAR. 3 – APR. 26
CHG 44 APR. 30 – JUN. 1
CHG 45 JUL. 6 – JUL. 31
CHG 46 SEP. 15 – OCT. 18
( ) NUMBER OF R. LAEVIS COLLECTED
0 – 140 M. HAUL
KAUAI
OAHU
MOLOKAI
MAUI
HAWAII

Fig. 1. Cruise periods, vessel positions during plankton hauls, and positions of larval occurrence of *Ranzania laevis*. HMS = *Hugh M. Smith*, CHG = *Charles H. Gilbert*.

TABLE 2. SEASONAL AND DAY-NIGHT VARIATION IN NUMBERS OF *R. laevis* COLLECTED IN 1957–58 FROM THE IGY PLANKTON STATION, 21°10′N., 158°19′W.

Date	Number of daylight tows	Number of *R. laevis*	Number of night tows	Number of *R. laevis*	Vessel and cruise
7/21/57	1	—	1	—	Charles H. Gilbert—34
8/20/57	1	—	2	—	" " " "
9/16/57	2	—	2	—	Hugh M. Smith—41
10/29/57	2	—	2	—	" " " "
11/26/57	2	—	2	—	" " " —42
12/19/57	2	—	2	—	Charles H. Gilbert—36
1/21/58	2	759	2	252	" " " —37
2/27/58	2	65	2	8	Hugh M. Smith—43
3/24/58	2	—	2	—	" " " —44
4/21/58	1	—	2	—	Makua—13
5/30/58	2	—	—	—	Charles H. Gilbert—39
6/21/58	2	—	2	—	" " " "
7/21/58	—	—	2	—	Hugh M. Smith—46
8/19/58	2	—	2	—	Charles H. Gilbert—41
9/25/58	2	—	2	—	" " " "
10/21/58	2	—	2	—	Makua—14
11/20/58	2	—	2	—	Hugh M. Smith—48
12/18/58	2	—	2	—	" " " —49
Total	31	824	33	260	

four contained *R. laevis* larvae (Table 2). In addition to the specimens found in the plankton samples, I examined nine juvenile *R. laevis* (12–82.5 mm T.L.) which were washed up at Maili, Oahu, where they were collected by Mr. K. Ego of the Hawaii Division of Fish and Game, during May 1959; and an adult female (335 mm T.L.) specimen collected from the stomach of

TABLE 3. SUMMARY OF DATA ON THE ONTOGENY OF *Ranzania laevis*

Panel A.—Selected morphological characters of *R. laevis* collected from the central North Pacific compared with the description of *R. laevis* larvae from the Sargasso Sea.

	Present study	Schmidt 1932 Fig. 197
Egg length in mm.	—	1.3–1.4
First larva		
Total length in mm	1.5–1.7	1.7
Spines	absent	absent
Caudal region	well developed	well developed
Second larva		
Early stage		
Total length in mm	1.8–2.2	1.8–2.4
Paired spines	7[1]	—
Unpaired spines	6	—
Caudal region	beginning to atrophy	beginning to atrophy
Middle stage		
Total length in mm	2.3–4.5	2.4–3.5
Paired spines	7	—
Unpaired spines	6	—
Caudal region	atrophying	atrophying
Late stage		
Total length in mm	4.6–8.0	8.0
Spines	diminishing in number and size	diminishing in number and size
Caudal region	greatly reduced	greatly reduced
Caudal fin	absent	absent

Panel B.—Morphometric and meristic data on juvenile *R. laevis* from Hawaiian waters

	Total length (snout to outer margin of caudal fin)	Fin ray counts				Vertebral count	Depth measured bisecting pectoral	depth/length
		P	D	A	C			
	mm.						*mm.*	
Early stage	12.0	13	18	18	21	—	8.5	.71
	14.2	13	18	18	20	—	8.5	.60
	18.5	13	18	18	20	—	10.0	.54
	23.0	13	18	18	21	—	10.5	.46
Late stage[2]	62.6	13	18	19	21	—	18.0	.29
	69.8	13	18	19	21	—	17.0	.24
	76.0	13	17	19	21	8 + 10	19.1	.25
	77.4	13	18	19	21	8 + 10	20.0	.26
	82.5	13	18	19	19	—	21.0	.25

Panel C.—Vertebral counts and depth/length relations of adult *R. laevis* from Hawaiian waters and specimen described from the Atlantic

	Total length (snout to outer margin of caudal fin)	Standard length	Fin ray counts				Vertebral count	Depth measured bisecting pectoral	depth/length
			P	D	A	C			
	mm.	*mm.*						*mm.*	
Adult[3]	335	321	13	damaged			8 + 10	121	.36 or .38[4]
Fraser-Brunner 1951:94	—	—	—	—			8 + 10 or 11	—	< .50

[1] An additional pair of poorly developed spines is present above orbit.
[2] Washed up on Maili Beach, Oahu.
[3] Found in stomach of marlin, *Makaira* sp., examined at United Fish Market, Oahu, 10/13/60.
[4] Using total length or standard length, respectively.

a marlin, *Makaira* sp., at the United Fish Market, Honolulu, on October 10, 1959.

According to Fraser-Brunner (1951, *Bull. British Mus. Nat. Hist. 1(6):96*), two subspecies of *R. laevis* can be recognized: *R. l. makua* Jenkins in the Pacific and *R. l. laevis* (Pennant) in the Atlantic. Major adult morphological features discussed by Fraser-Brunner are carapace depth and the position of the pectoral fin axil. For *R. l. makua* he reports that carapace depth is greater than half the length, and the axil is located above the center of the eye. In *R. l. laevis* carapace depth is reported less than half the length, and the pectoral fin axil is located below the center of the eye. The adult specimen collected during the present study agreed on these points with the description of *R. l. laevis* given by Fraser-Brunner (Table 3, panel C).

The developmental stages of *R. laevis* found in the plankton samples were compared to the descriptions by Schmidt (1932, *Dana's Togt omkring Jorden: 250–5*) and Tortonese (1956, *Fauna e Flora del Golfo di Napoli, Monog. 38: 965–71*). Excellent agreement was found between the lengths and changes in form of the caudal region at various larval stages as given by Schmidt (*ibid.*, fig. 197) and as seen in my specimens (table 3, panel A). The number of spines, seven paired and six unpaired, found in specimens measuring 2.3–4.5 mm was in agreement with the number found by Tortonese (*ibid.*, 970) in a 2.8-mm specimen collected from the Strait of Messina.

Perhaps some of the confusion found in the literature regarding the nomenclature of *R. laevis* is attributable to the marked changes in form which are characteristic of this fish. The number of pectoral fin rays (13) and the vertebral count (8 + 10) of the juvenile *R. laevis* collected from the beach at Maili, Oahu, are in agreement with corresponding counts given by Fraser-Brunner for adult specimens. However, the depth/length ratio of these juvenile specimens (Table 3, panel B) varies from 0.71 in a 12-mm (T.L.) specimen to 0.25 in an 82.5-mm individual, indicating a change in body form with increase in length. Carapace depth in the older specimens of *R. laevis* is less than half the length, as evidenced from the 335 mm adult collected during the present study, in which the depth/length ratio was found to be <0.50 (Table 3, panel C). Although only one adult was examined, the resulting measurements, when considered with the similarity in larval development between Atlantic specimens and the present series of Pacific specimens, suggest that *R. laevis* is distributed in both Atlantic and Pacific waters.

The only definite record regarding spawning grounds of *R. laevis* is that of Schmidt (1921, *Nature, Lond. 107:76–79*), who reported that viable *R. laevis* eggs (referred to as *R. truncata*) were collected from depths of approximately 100 m in the Sargasso Sea and hatched aboard the *Dana*. In the present study *R. laevis* larvae were collected in varying numbers throughout the entire survey region with no apparent concentration in any one sector (fig. 1). The greatest numbers of *R. laevis* were found in plankton samples collected during late winter and early spring (table 1) in the oceanographic survey series, and during January and February in the IGY collections (table 2). Considerably greater numbers of *R. laevis* were found in the daylight than in the night samples. Abundance of *R. laevis* in all stages of larval development from January to April indicated that considerable spawning had occurred. Absence of appreciable numbers of larval stages during other months of sampling suggests that *R. laevis* spawns only during the late winter and early spring in the Hawaiian region.

In this connection it is noted that the adult ♀ *R. laevis* collected at the United Fish Market, Oahu, in October 1960 contained a large number of developing opaque yellowish ova measuring 0.5 mm. in diameter.

Whether the juvenile *R. laevis* washed up at Maili, Oahu, were members of the 1959 year-class is open to speculation in the absence of adequate growth data.

I am indebted to Messrs. Gary Miller and Edward Kamaura of the HBL for their assistance in the tedious work of separating *R. laevis* from other plankton constituents, and also to Mr. Wilvan G. Van Campen of the HBL staff for his translation of pertinent passages in Danish and Italian publications.—KENNETH SHERMAN, *United States Department of the Interior, Bureau of Commercial Fisheries Biological Laboratory, Honolulu, Hawaii.*

THE AFFINITY AND THE GENERIC NAME OF *CENTROPRISTIS SUBLIGARIUS* COPE.—During a recent visit to Florida, my attention was called on the problems concerning the classification of some American Serranidae. It seems that at least a few generic names in this family of fishes are quite superfluous, as they can easily be considered as synonyms, and that the affinities and the systematic position of several species have not been properly established. One of such species is the belted sandfish, described as *Centropristis subligarius* by Cope (1870, *Proc. Acad. Nat. Sci. Phila. 22:120*) after specimens from Pensacola, Florida. Subsequent

authors quoted it under different generic names: *Dules* Cuvier (1829); *Serranellus* Jordan and Eigenmann (1890); and *Callidulus* Fowler (1907). In the recent literature, this fish is usually named *Serranellus subligarius* (Cope).

For its general appearance it is very like *Serranus scriba* (Linnaeus), which is common in the Mediterranean and eastern Atlantic. At first sight, we are lead to suppose that these species belong to the same genus. It is interesting to point out that *Perca scriba* of Linnaeus was considered by Jordan and Eigenmann (1890, *Bull. U. S. Fish. Comm. 8:399*) as the type of their genus *Serranellus*; however, such a generic name was almost never applied. According to the prevailing opinion of the Mediterranean ichthyologists, the name *Serranus* Cuvier (1817: type *Perca scriba* L.) must indeed be used for the small species of basses (*S. scriba, S. cabrilla,* etc.) and *Epinephelus* Bloch (1793: type *E. marginalis* = *Perca fasciata* Förskal) for the larger ones (*E. guaza, E. aeneus,* etc.). If we admit that *Serranellus* is nothing but *Serranus,* it would appear that the inclusion of *scriba* and *subligarius* in the same genus is not open to question. However, we preferred to have these species more carefully compared. A visit to the Marine Laboratory of Cape Haze, Placida, Florida (April 1960) was a welcome occasion for becoming acquainted with "*Serranellus*" *subligarius* and we feel very obliged to Mrs. Eugenie Clark for her kind permission of examining specimens collected by her in the Gulf of Mexico and for taking a few to the Museum of Genoa. Here their morphological characters have been investigated and found to be very like those of *S. scriba*. In both species are to be observed the main features of the genus *Serranus*, which are listed as follows.

Rather small size. Mouth large. No maxillary supplemental bone. Conical, pointed teeth with some larger ones in both jaws. No depressible teeth. 6–7 branchiostegal rays. No scales on the interorbital, suborbital, maxillary and lower jaw. Opercles and cheeks scaled. Preopercular border serrate, its lowermost part excepted. Opercle with 2–3 flat points. Ctenoid scales. Dorsal rays X.13–15. No elongated fin rays. Caudal fin truncate or nearly so. Vertebrae 24 (10 + 14). Hermaphroditic.

After our comparison of *S. subligarius* (Boca Grande, Florida) with *S. scriba* (Bay of Genoa), the former species was found to differ from the latter for its size (smaller), its color (dark vertical bands are missing; there is a large blackish blotch about on the middle of dorsal fin, somewhat extended on back) and several morphological characters. The general shape of the body is much the same, but the comparative height is greater (about 2.50–2.75 in length, instead of about 3). There are 6 branchiostegal rays (not 7) and 8–9 gillrakers (followed by a few rudimentary ones) on the lower part of the first branchial arch (*S. scriba* has 7–8, longer). The teeth, as a whole, are smaller, their size being more uniform. The scales are larger (about 50 along the lateral line instead of about 70) and the dorsal soft rays are fewer (13 instead of 14–15).

All these differences cannot be interpreted as more than specific. Therefore, both species are to be considered as congeneric and *Serranus* is the common name for them. *S. scriba* and *S. subligarius* are rather closely related also from a biological point of view. They live near the shore, at small or moderate depth, on rocky bottom or—in the case of *S. scriba*—on the beds of *Posidonia*. Both are noteworthy for their functional hermaphroditism. As far as its distribution is concerned, the genus *Serranus* is amphi-Atlantic, having representatives on the opposite sides of this ocean. The other common Mediterranean species show more marked differences from *S. subligarius*. The latter is of interest when the littoral fish faunas of the Western Atlantic and of the Mediterranean are compared and the affinities of their components are looked for.—Enrico Tortonese, *Museum of Natural History, Genoa, Italy.*

ADHESIVE APPARATUS OF AN INDIAN HILL-STREAM SISORID FISH, *PSEUDECHENEIS SULCATUS*.—Studies on the adhesive apparatus of hill-stream fishes have been made by Hora (*Rec. Indian Mus. 24:47–58, 1922*); Rauther (*Zool. Jahrb. Physiol. 45:45, 1928*); Wu and Liu (*Sinensia, 11:69–75, 1940*); Bhatia (*Proc. Natl. Inst. Sci. India, 16:271–85, 1950*); and Saxena (*ibid, 25:205–14, 1959*). The present observation on the adhesive apparatus of *Pseudecheneis sulcatus* (McClelland) reveals some interesting histological peculiarities. The skin on its ventral surface, between the pectorals, is modified into 13 or 14 transverse ridges alternating with grooves forming an oval adhesive apparatus. The habitat of *P. sulcatus* (Family: Sisoridae) ranges from the Darjeeling Himalayas to North East Burma.

Histological study of the adhesive apparatus of *P. sulcatus* shows that modifications have taken place in the epidermis on the ridges while the epidermis in the grooves is similar to that of normal skin. The epidermis on each ridge (Figs. 1 and 2) consists of two spinous layers, two intermediate rows of partly formed spines and three to four layers of polygonal epithelial cells

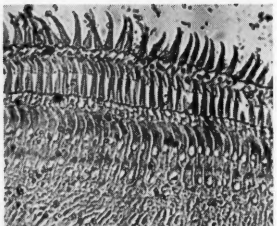


Fig. 1. Photomicrograph of the longitudinal section through ridge of the adhesive apparatus of the sisorid fish *Pseudecheneis sulcatus*.

which are budded off from the columnar epithelium of the stratum germinativum. The spines are absent in the grooves but under high magnification the presence of a thin stratum corneum can be detected. A few mucous and sensory cells occur at random in the grooves.

The outermost epidermal layer consists of completely cornified spines. Below the spines is a row of basal or hold-fast cells from which the cytoplasm extends in to the bases of the spines. The basal cells form the caps into which fit the apices of the underlying spines of the second row. Each cap is formed by the two neighboring cells which have prominent nuclei. The second layer also consists of spines which are only partially cornified and the spines are separated from one another by spaces. Each spine of the second row is marked off from its basal cell by a constriction. The basal cells of the second layer neither form caps like those of the first nor are their nuclei prominent.

The third and the fourth intermediate spiny layers consist of elongated epithelial cells. The upper halves of these cells in the third layer and only the tips of the cells in fourth layer are partially cornified. The nuclei in all these cells lie basally. The spines of all the four layers are pointed in one direction. The three or four layers of polygonal epithelial cells rest on a single row of columnar cells of the stratum germinativum. The nuclei in these cells are also rather indistinct.

Such an arrangement of four successive spiny layers and the formation of caps by the basal cells have not hitherto been reported in the skin or its modifications in any fish. The occurrence of a single layer of spines has been described in the Sisorid fishes, *Glyptothorax madraspatanus* (Hora, 1922) and *G. telchitta* (Bhatia, 1950), whose thoracic adhesive apparatus are also provided with alternate longitudinal ridges and grooves. A similar condition was also described by Hora (1922) in the pectoral adhesive apparatus of *Bhavania annandalei* (Homalopteridae); *Garra annandalei* (Cyprinidae) and *Glyptosternum labiatum, G. saisii* and *Gyptothorax dorsalis* (Sisoridae).

The dermis in the adhesive apparatus of *Pseudecheneis sulcatus* consists of thick bundles of collagen fibres which stain red in van Gieson and Verhoeff's elastic tissue stains and blue in

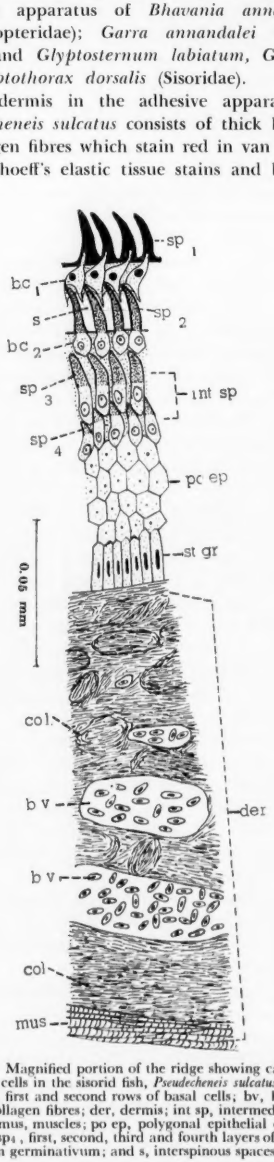


Fig. 2. Magnified portion of the ridge showing caps of the first basal cells in the sisorid fish, *Pseudecheneis sulcatus*. Legend: bc 1, bc$_2$, first and second rows of basal cells; bv, blood vessel; col, collagen fibres; der, dermis; int sp, intermediate layer of spines; mus, muscles; po ep, polygonal epithelial cells; sp$_1$, sp$_2$, sp$_3$, sp$_4$, first, second, third and fourth layers of spines; st gr, stratum germinativum; and s, interspinous spaces.

Lee-Brown modification of Mallory's stain. Below the collagen fibres are attached the muscles of the abdominal region. The collagenic dermis has a rich vascular supply. In unmodified skin, the dermis consists of thin fibrous stratum compactum which is collagenic as shown by the staining reactions. It would appear that the thick collagenic dermis of the adhesive apparatus is derived from the stratum compactum of the unmodified skin. Bhatia (1950:279) has reported the presence of a circular layer of muscles immediately below the epidermis in the adhesive apparatus of *Glyptothorax telchitta*. However, this may be an error since histochemical tests on the adhesive apparatus of other members of the genus do not confirm Bhatia's observations.

The spines develop from the polygonal epithelial cells lying immediately below the fourth spinous layer. The epithelial cell destined to give rise to a spine, elongates and develops a conical tip. The nucleus remains in the lower end which ultimately becomes the basal or the hold-fast cell. Cornification starts from the tip and gradually extends downwards. The nucleated part is demarcated in the cell wall by a small constriction which also denotes the extent of the spinous portion of the cell. The nuclear division is not seen at any stage. Finally, with the complete cornification of the spinous portion, the nucleated part or the basal cell becomes dissociated from the spine. However, the cytoplasmic extension from the basal cell projects into the base of the spine.

The development of spines in the adhesive apparatus of *P. sulcatus* differs from that of *Garra mullya* (Saxena, 1959:211). This study has also revealed the manner in which the spines are shed. The worn out spines are shed with their basal cells whose caps are detached from the apices of the underlying spines. A second tier of already formed spines with their basal cells now moves forward and takes up the outermost position.

My grateful thanks are due to Dr.(Miss) M. Chandy for her guidance and constant encouragement and to Prof. B. R. Seshachar for providing the facilities and for going through the manuscript.—SUBHASH CHANDRA SAXENA, *Department of Zoology, University of Delhi, Delhi, India*

RELATIVE GROWTH OF FINS IN THE FOURHORN SCULPIN, *MYOXOCEPHALUS QUADRICORNIS*, FROM THE UPPER GREAT LAKES.—Sexual dimorphism and relative growth of body parts long have offered difficulties to fish taxonomists. These difficulties have been particularly acute in the fourhorn sculpin, *Myoxocephalus quadricornis* (Linnaeus). See Berg and Popov (1932, *C. R. Acad. Sci. U. S. S. R. 6:152–62*) for a review of the synonymy of the species and for justification for use of the present name. The fourhorn sculpin was long known to American workers as deepwater sculpin, *Triglopsis thompsoni* (e.g., Hubbs and Lagler, 1947, *Bull. Cranbrook Inst. Sci. (26):1–186*). Jordan and Thompson (1910, *Proc. U. S. Nat. Mus. 38:75–8*) for example, were obviously unaware of the striking sexual dimorphism in this species, and the specimens figured by them as *Triglopsis ontariensis* and *T. stimpsoni* are male and female, respectively.

The relative growth of the fins of the fourhorn sculpin was studied to determine: the extent of sex differences in fin growth; the rate at which relative growth progresses; points of inflection in growth lines; whether inflection of the relative growth lines is associated with development of the gonads.

Of a total of 184 specimens examined, 134 were collected in Lake Superior in the region of Isle Royale and the Keweenaw Peninsula, Michigan, during August 1952 and May 1953; 38 were gathered in Lake Michigan off Manitowoc, Wisconsin, on June 17, 1952; and 12 were taken in Lake Huron in the vicinity of Harbor Beach, Michigan, on September 16, 1952. The collections were made from the research vessel *Cisco* of the Ann Arbor Biological Laboratory, Bureau of Commercial Fisheries. The specimens were preserved in 10-per cent formalin and later soaked in water and transferred to 70-per cent ethyl alcohol.

The relative growth of the fins was investigated by plotting the lengths of the longest rays (measured from their structural bases to their tips) and the standard length of the fish on logarithmic paper and fitting the best straight lines through the points by inspection. These lines are representative of the relative growth of the body part considered (Huxley, 1932, Problems of relative growth. *London, Methuen & Co. Ltd. 276 pp.*). Data for sexually undeveloped fish fell along the same straight line as those of mature females. The immature individuals were those in which the sex could be determined only by histological examination of the gonads; the largest fish in this group was 40 mm long. The relative growth lines of mature males (largest fish, 139 mm) were plotted separately, and were superimposed upon those of the juveniles and the larger females.

The number of specimens employed to determine the slope of the growth lines of the various fins, ranged from 47 to 52, depending upon the

TABLE 1. GROWTH CONSTANTS AND POINTS OF INFLECTION IN THE RELATIVE GROWTH OF FINS IN *Myoxocephalus quadricornis* OF LAKES SUPERIOR, MICHIGAN, AND HURON

Fin	Slope of growth line		Standard length of males at inflection of growth line (mm)
	Mature males	Mature females and both sexes at 40 mm and less	
Second dorsal	2.02	1.19	40
Pelvis	1.59	1.20	42
Anal	1.48	1.18	41.5
First dorsal	1.45	1.24	31
Pectoral	1.17	1.04	37
Caudal	1.00	0.94	39

number of points that were necessary to establish the slopes of the lines satisfactorily. The specimens included some individuals from all localities in which collections were made. The scatter of the points representing measurements of fish captured in Lakes Superior, Huron, or Michigan, exhibited no pronounced differences.

The relative size of the caudal fin remained constant in mature males (slope of 1.00—Table 1) and decreased slightly with increase of fish length among immature fish and adult females (slope, 0.94). The relative lengths of all other fins increased, however, with increase of length in both groups of fish. The rate of increase varied widely from fin to fin but without exception was decidedly greater for mature males than for females and immature males.

The slope of the relative growth line in mature males was greatest for the second dorsal fin (2.02—also see Fig. 1), had values between 1.59 and 1.45 in the pelvic, anal, and first dorsal fins, but was only 1.17 for the pectoral fin. For mature females and immature fish the growth constants ranged between 1.24 (first dorsal) and 1.04 (pectoral).

The females and immature sculpins differed from mature males further in the failure of the second dorsal fin to exhibit a much larger growth constant than any other fin. The slope of 2.02 for the relative growth line of the second dorsal of mature males was much greater than that for any other fins. The slope for the second dorsal of immature fish and adult females (1.19) was similar to that for the pelvic, anal, and first dorsal fins. In neither the mature males nor the immature fish and mature females was there any clear indication of a correlation between relative growth rate and position of the fin along the longitudinal axis.

The conformity of the relative growth of fins in immature males with that of females (mature and immature) proves that the relative growth of fins of males undergoes an inflection at about the length of fish at which sex could be determined by visual inspection. Thus, the accelerated growth of fins of males sets in at attainment of maturity. The estimates of the length of fish at the inflection of the relative growth line range from 31 mm for the first dorsal fin to 42 for the pelvic fin (Table 1). Five of the 6 estimates fall within the range of 37–42 mm and 4 are from 39 to 42 mm. No judgment is offered as to the extent to which the variation in estimates of point of inflection may reflect true differences in the course of relative growth of the various fins.

The relative growth of the fins in *Myoxocephalus quadricornis* is unusual not only for the high values of the growth constants (especially in mature males) but also for the persistence of a substantial departure from isogonic growth to the greatest lengths of fish in the samples. Any considerable deviation of a growth constant from unity leads to pronounced changes of body proportions. If the heterogonic growth is maintained over a sufficiently long interval these changes can approach the monstrous. Such a situation holds for males of the sculpin (Fig. 2), which at greater lengths exhibit second dorsal fins whose posterior tips extend al-

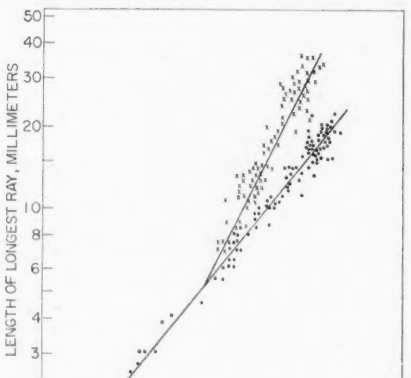


Fig. 1. Relationship between standard length of fish and length of the longest ray of the second dorsal fin in *Myoxocephalus quadricornis* in Lakes Superior, Michigan, and Huron. The crosses give values for individual mature males; the dots for females at 40 mm and greater, and for sexually undifferentiated individuals at shorter lengths. The two lines were fitted by inspection.

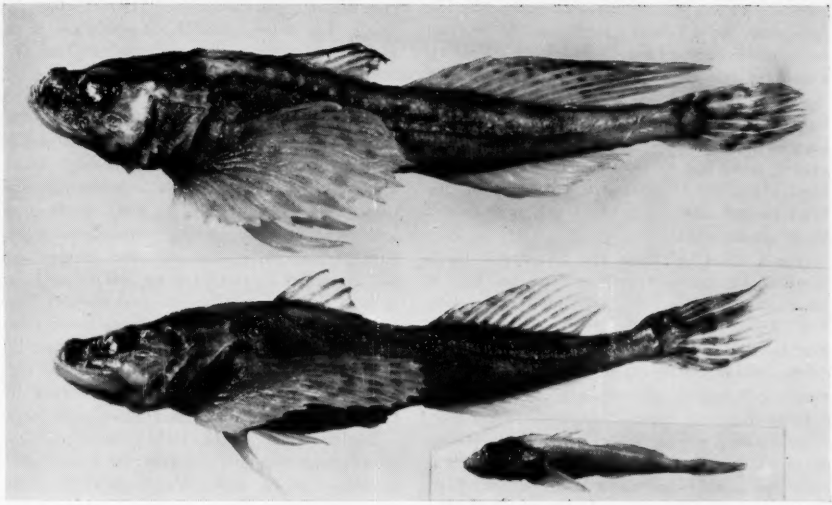


Fig. 2. Mature male fourhorn sculpin (141 mm, top), mature female (140 mm, center), and small male (54 mm, bottom). The small male was the shortest fish suitable for photographing available in the collections. All 3 fish were caught in Lake Michigan at 50 fathoms off Grand Haven, Michigan, Oct. 21, 1961. [Photograph by William Cristanelli]

most to the tip of the tail. The proportions in large females are much less extreme but large fish of both sexes exhibit sharp differences from the small, immature sculpins.—CARL JACOBY, *Ann Arbor Biological Laboratory, Bureau of Commercial Fisheries, Ann Arbor, Mich.; present address: 2216 Stanbridge Ave., Long Beach, Calif. Contribution from the Department of Fisheries, the University of Michigan, and the Ann Arbor Biological Laboratory, U. S. Bureau of Commercial Fisheries.*

FIRST RECORDS OF THREE NORTHERN FISHES FROM THE UPPER GULF OF CALIFORNIA.—The following range extensions are partial results of the California Department of Fish and Game cruise of the MV Alaska into the Gulf of California during January and February, 1960. Mr. Leo Pinkas, biologist in charge of the trip, kindly made the specimens available to the author. They are now deposited in the collection of fishes of the University of California, Los Angeles.

Hydrolagus colliei (Lay and Bennett). One male ratfish, 433 mm in total length (UCLA 60–56), was captured in an overnight gillnet set at a depth of 75 fathoms south of Isla Tiburon (lat. 28° 38′ N., Long. 112° 19′ W.). This specimen had been partially consumed by marine animals before the gillnet was retrieved, but enough remained for positive identification when compared with individuals from California waters.

Cephaloscyllium uter (Jordan and Gilbert). Nine specimens of this swell shark were captured from the following localities: Isla San Esteban (Lat. 28° 41′ N., Long. 112° 33.9′ W.), UCLA 60–12, 1 (767 mm), UCLA 60–54, 4 (675–810 mm); Isla Tiburon (Lat. 28° 45′ N., Long. 112° 23′ W.), UCLA 60–55, 4(660–695 mm).

The Gulf of California specimens agree with five specimens of *C. uter* in the UCLA fish collection from California. Garman (1913, *Mem. Mus. Comp. Zool. Harvard 36: 80, pl. 9, fig. 6–9*) combined *C. uter* and *C. ventriosum* (Garman), stating: "Specimens from California differ from the type (from Chile) mainly in being somewhat darker". Although Garman (1899, *Mem. Mus. Comp. Zool. Harvard 24:26*) recorded *C. ventriosum* from Acapulco, the author is in agreement with Beebe and Tee-Van (1941, *Zoologica 26(2):99*) in considering the northern form *C. uter* as distinct from *C. ventriosum*.

All 14 specimens examined displayed considerable variation in the characters used to separate *C. uter* and *C. ventriosum*. The overall color intensity is variable, ranging from quite dark to moderately light. The 6 to 11 dark dorsal bars (excluding the caudal fin) were quite pronounced in the lighter individuals but were difficult to distinguish in the dark individuals. Four specimens had small teeth in the symphysis

of the lower jaw while the remaining 10 specimens had a naked symphysis. The rows of teeth in the upper jaw ranged from 51 to 61, the lower jaw from 45 to 55. The number of cusps on the teeth were normally three, one large center cusp flanked by one small cusp on each side. In the specimens examined, the cusps ranged from one to five, with three being the most common. The relative broadness of the head ranged from more than to less than the length of the head.

The vertical height of the first dorsal fin is consistently somewhat greater in males than in females. Evermann and Radcliffe (1917, *Bull. U.S. Nat. Mus. 95:3–5*) mentioned finding a similar difference in *Halaelurus chilensis* (*Guichenot*), along with a variation in the arch of the mouth between males and females.

Cetorhinus maximus (Gunnerus). One partially decomposed carcass of an 11 foot basking shark was observed on the road between Puertecitos and San Felipe, about five miles north of Puertecitos, Baja California, 1 February, 1960 (UCLA 60–19). How this animal arrived at this remote spot is unknown, but it is inconceivable that it could have been captured from an area other than the Gulf of California in the vicinity of either Puertecitos or Bahia San Luis Gonzaga, Baja California. Although the jaws were missing, the extremely long gill-slits, lunate caudal fin, the keel on each side of the caudal peduncle, and the large size identify this animal as *Cetorhinus maximus*. Mr. John E. Fitch of the California Department of Fish and Game confirmed the identification.

An additional record of *C. maximus* from the Gulf is based on a number of gill rakers found near the remains of a large shark on the beach at Punta Peñasco, Sonora, Mexico (UCLA 59–109). The size and shape of the gillrakers agree well with the description and figure of Bonham (1942, *Copeia (4):264–66, fig. 5*).—Wayne J. Baldwin, *Department of Zoology, University of California, Los Angeles, California.*

FOUR RANGE EXTENSIONS OF FISHES FROM THE NORTHEASTERN PACIFIC.—Range extensions for two smelt, a sea poacher, and a sculpin, were established during the summer of 1960. Three of these species are recorded here as new to Alaska. The fishes were captured during trawling operations conducted by the International Pacific Halibut Commission during studies on young halibut aboard the M/V COMMANDO, the research vessel of the College of Fisheries, University of Washington. The fishes were taken in an eastern type otter trawl with 1¼ inch stretched cotton mesh in the cod end and 2½″ stretched mesh in the body and wings. The collection and identification of the fishes was done by the author.

Spirinchus starksi (Fisk). Night smelt.—Sixty specimens from 62 mm to 117 mm S. L. (standard length) were taken on September 12. The fish were taken at 57° 08′ N, 135° 48′ W, in Shelikof Bay, Kruzof Island (near Sitka), Alaska, at a depth of 11 fathoms. The following measurements and counts are recorded as the mean and the range of 10 randomly selected specimens: S.L., 101 mm (81 mm to 109 mm); longest anal fin ray (as per cent of S.L.), 9.6% (8.6% to 10%); longest pectoral fin ray (as per cent of S.L.), 16.6% (16% to 17%); number of pectoral fin rays, 11.3 (10 to 12); and number of dorsal fin rays, 10.7 (10 to 12). This identification has been verified by Don E. McAllister, Curator of the Canadian National Museum, Ottawa.

Schultz (*Univ. Wash. Publ. Biol. 2(4)*, 1936) records the northern limit of the range of *S. starksi* to be La Push, Washington. McAllister has informed me of an unpublished record in the University of British Columbia Collection from the east coast of Queen Charlotte Island near 54°30′N, 131°50′W taken by B. Lister. The Alaskan record is a northerly extension of 770 miles from La Push and of over 275 miles from the Queen Charlotte records. It is the first record from Alaska.

Spirinchus thaleichthys (Ayres). (=*S. dilatus* Schultz and Chapman) Longfin smelt.—Three collections of this species were made along the coast of Alaska. Single specimens were obtained at 59°30′N, 139°52′W, off Yakutat Bay on July 5, in 11 fathoms and at Kayak Island, 59°52′N, 144°30′W, on September 6, in 16 fathoms. The most northerly collection was made at 60°12′N, 146°15′W, near Hinchinbrook Island off Prince William Sound. Eighty five specimens from 86 mm to 126 mm S.L. were obtained there in 11 fathoms on July 9. McAllister has examined and verified the identification of these specimens. In a letter of March 10, regarding the synonomy of *S. dilatus* with *S. thaleichthys*, he stated (quoted by permission) "... it became apparent that the characters used to separate *dilatus* from *thaleichthys* are clinal—the length of the pectoral fins decreases and the number of lateral scales increase northward. Since there is no sharp break in the cline and no other characters were discovered separating '*dilatus*' from *thaleichthys*, I regard *dilatus* as a synonym of *thaleichthys*." The following measurements and counts from ten Alaskan specimens are recorded as before: standard length, 105 mm (92 mm to 122 mm); longest anal fin ray, 12.1% (11% to 13%); longest pectoral fin ray, 20.7% (19% to 22%); number

of pectoral fin rays, 11.6 (11 to 12); and number of dorsal fin rays, 10.7 (10 to 11).

Clemens and Wilby (*Fish. Res. Brd. Canada, Bull. 68,* 1948) record the northern limit of the range of *S. thaleichthys* as Prince Rupert, British Columbia. Previous reports of *S. thaleichthys* in Alaska have resulted from a confusion with *Hypomesus olidus* (Hubbs, *Proc. Biol. Soc. Wash. 38,* 1925). The specimens described herein appear to be the first authentic record from Alaska. The specimens from Hinchinbrook represent a northerly extension of 800 miles from Prince Rupert and are a second new addition to the list of Alaskan fishes.

Occa verrucosa (Lockington). Warty poucher. —Two specimens were taken in Shelikof Bay on June 30, at a depth of approximately 16 fathoms. The fin counts of both specimens are as follows: dorsal fins, VIII-8 and VIII-7; anal fin, both 12; pelvic fin, both I-2; and pectoral fin, both 15.

Clemens and Wilby (*op. cit.* 1948) record three specimens from Florencia Island, off Vancouver Island, British Columbia. The two specimens from Shelikof Bay, Alaska represent a northerly extension of nearly 700 miles and a third addition to the list of Alaskan fishes.

Triglops forficata (Gilbert).—One specimen was obtained at 57°04′N, 152°16′W, on Albatross Bank in 42 fathoms off the southeast coast Kodiak Island with the following counts: dorsal fins, XI-30; anal fin, 32; pelvic fin, I-3; and pectoral fin, 22.

Wilimovsky (*Fish. Res. Lab., U.S. Fish & Wildl. Serv.* 1958) records this as a Bering Sea fish although it was originally described from specimens caught south of Sanak Island (south of the Aleutian chain) as well as north of Unimak Island (*Rept. U.S. Comm. Fish & Fish.* for 1893, 1895). The specimen from the coast of Kodiak Island represents an eastward extension of nearly 450 miles from Sanak Island.

This entire collection of fishes has been deposited in the collection of the College of Fisheries, University of Washington.—R. L. Dryfoos, *College of Fisheries, University of Washington, Seattle, Washington. Contribution No. 96 from the College of Fisheries, University of Washington.*

EARLY NOMENCLATURAL HISTORY OF THE NOMINAL CYPRINID GENUS *OREGONICHTHYS* AND OF THE BLENNIOID, *PHOLIS SCHULTZI*, FISHES OF WESTERN NORTH AMERICA.—During our early studies of the fishes of Washington and Oregon, inadvertently and regretfully we have caused some nomenclatural confusion that we have intended to clarify for over a quarter of a century. A letter from Mr. G. Palmer, British Museum of Natural History, current author of the Pisces section of the Zoological Record, requesting information that would help clarify this confusion, prompts us, after all of these years, to publish this note to outline the detailed early history of the involved nomenclature.

Oregonichthys Hubbs *in* Schultz, 1929

In his "Check-list of the Freshwater Fishes of Oregon and Washington" Schultz (*Publ. Fish. Univ. Wash. 2(4):47,* January, 1929) included "*Oregonichthys crameri* (Snyder)" at the suggestion of Dr. Hubbs, with the following footnote, "New genus proposed by Hubbs and recognized in Jordan and Evermann's forthcoming check-list, taking the place of *Hybopsis* [for this species]." This was the first published mention of *Oregonichthys*. The second published account of "*Oregonichthys* Hubbs" was by Jordan, Evermann, and Clark (*Rept. U. S. Comm. Fish 1928, Pt. 2:138,* February 1930), who cited a reference to a paper by Hubbs for 1927 which was never printed. A type species was selected by Jordan, Evermann, and Clark by the inclusion in parenthesis under the generic name, the species *Hybopsis crameri* Snyder, as this was obviously their method of indicating the type species of genera. They listed a second species, *Oregonichthys cumingii* (Günther), a species not involved in the problem of the nomenclatural availability of *Oregonichthys*. Currently, *Oregonichthys* is treated as a synonym of *Hybopsis*, though it may rank as a subgenus.

Oregonichthys Hubbs *in* Schultz 1929, was not diagnosed until Schultz (Key to the fishes of Washington and Oregon with a glossary of technical terms, *Univ. Bookstore, Seattle, p. 22,* October 31, 1931) keyed it out in this mimeographed publication, 200 copies of which were sold and distributed. *Oregonichthys crameri* (Snyder) was next listed by Schultz and DeLacy (*Mid-Pacific Mag. 10:(4):380, 1935*) and without a diagnosis. Schultz (*Univ. Wash. Pub. Biol. 2 (4):147, 1936,* revised edition March, 1938) again diagnosed the genus.

Pholis schultzi Hubbs *in* Schultz, 1931

Hubbs (*J. Pan-Pacific Res. Inst. 3(2):11, 15 July–September, 1928*) published the name *Pholis schultzi* in his list of the marine fishes of Oregon and Washington and stated, p. 10, "A new species of blennioid fish from the West Coast of the United States, Occ. Pap. Mus. Zool. Univ. Mich. (in press)." Since he (l. c. p. 15) further states, "A reef species ranging from Puget Sound to Del Norte County, California," only the name as of 1928 was clearly a nomen nudum.

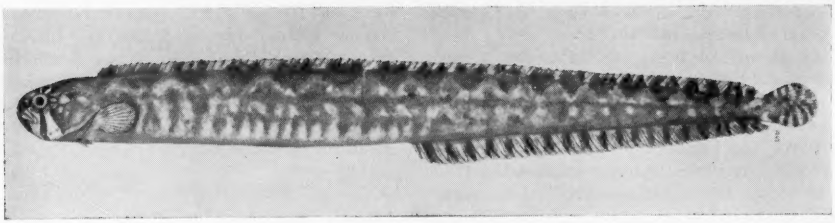


Fig. 1. *Pholis schultzi* Hubbs, USNM 195955, lectotyp Drawn by Mrs. Dorothea B. Schultz.

Schultz included a diagnosis of *Pholis schultzi* Hubbs in a mimeographed publication (Key to the fishes of Washington and Oregon with a glossary of technical terms, *Univ. Bookstore, Seattle, p. 45,* October 31, 1931) of which 200 copies were sold and distributed. Schultz and DeLacy (*Mid-Pacific Mag., 11:139 April–June, 1936*) published the name *Pholis schultzi* Hubbs and referred to Schultz's publication of 1931, thus indicating that they considered the 1931 paper as published. We concur in this interpretation, despite the circumstance that Schultz, in a later paper, (*Univ. Wash. Publ. in Biol. 2: 192, 1936,* revised edition 1938) changed his mind about his 1931 paper representing publication. He listed only the generic name *Pholis,* with the following footnote: "This species appeared as a nomen nudum in the check-list by C. L. Hubbs (1928) Jour. Pan-Pacific Research Inst. and again in this key when first mimeographed. It is to be described by Hubbs in the near future." Hubbs, however, never has published a description of *Pholis schultzi.*

The diagnosis of this species (Fig. 1) included in Schultz's papers of 1931 and 1936 was based on 3 lots as follows: USNM 117582, collected by Hubbs and Schultz, at Ecola Rocks, Clatsop County, Oregon, July 24, 1926, 3 specimens; USNM 104367, collected by L. P. Schultz and W. M. Chapman at Cape Johnson, Washington, May 30, 1930, 6 specimens; and USNM 104366, collected by L. P. Schultz at Cape Johnson, June 1, 1931, 30 specimens, all of which we consider to be type specimens. Herewith we select a specimen from the June 1, 1931 lot as the lectotype of *Pholis schultzi* Hubbs *in* Schultz, 1931 and 1936. It has been assigned USNM 195955.

Makushok (*Proc. Zool. Instit.* [*Trudy Zool. Inst. Akad. Nauk. S.S.S.R.*] *25:62, 122–3, 1958*) cited "64. *Ph. schultri*" with a footnote reference "Hubbs in: Schultz 1936:192." Obviously "*schultri*" was a typographical error for *schultzi*; as on page 62 he listed under the synonymy of the Pholinae "*Ph. schultzi* Hubbs (in: Schultz, 1931), though in the bibliography he included only a reference to Schultz's 1936 paper.

Under a strict interpretation of the rules the species *Pholis schultzi* should be accredited to Schultz, since it was not stated in the original description (cf. Schultz, 1931 or of Schultz, 1936, if the earlier paper be interpreted as not published) that Hubbs was responsible for the name and the indication. However, since the material used by Schultz had been examined by Hubbs in the initial, unfortunately, unpublished distinction of the species, and the species has consistently been attributed to Hubbs (Bailey, Lachner, et al. *Am. Fish. Soc., Spec. Publ. (2):43, 1960*) and since the combination *schultzi* Schultz would be unfortunate, the authors are applying to the International Commission for a suspension of the Rules, so as to retain the continued attribution of the species to Hubbs.—Leonard P. Schultz, *U. S. National Museum, Smithsonian Institution, Washington 25, D. C.* and Carl L. Hubbs, *University of California, Scripps Institution of Oceanography, La Jolla, California.*

LARVAL CARAPID FISHES FROM HAWAII, WITH REMARKS ON THE ECOLOGY OF ADULTS.—Midwater trawling ten miles off Waianae, Oahu, Hawaiian Islands, from the U. S. Bureau of Commercial Fisheries research vessel *Hugh M. Smith,* resulted in the capture of one vexillifer and two tenuis larval stages of the family Carapidae. The vexillifer is 64 mm in length and the tenuis 157 and 200 mm. Attempts to identify these larval pearlfish with their respective adult forms led to a brief examination of the biology of this family as represented in Hawaii.

Gosline and Brock (*Handbook of Hawaiian fishes, p. 280,* 1960) record *Snyderidia canina* Gilbert, *Encheliophis gracilis* (Bleeker), *Carapus margaritiferae* (Rendahl), and *Carapus homei* (Richardson) from Hawaii. Their material has been seen, with the exception of *Snyderidia,* along with additional adult specimens from the Bureau of Commercial Fisheries collections. Thanks are due Dr. W. A. Gosline, University of Hawaii, for the loan of his material, and Dr.

D. C. Arnold, College of the Venerable Bede, for opinions on identification.

With only four carapids known from Hawaii, the problem of relating the larval and adult stages was not particularly difficult. There is, however, the possibility of the larvae being the young of an unknown adult. The fact that the anal fin commenced anterior to the dorsal fin eliminated *Snyderidia* from consideration, while pectoral ray counts of 19–20 and anal ray counts of 196–241 eliminated *Carapus margaritiferae*, the adults of which have 13–14 pectoral and 161–163 anal rays. To determine whether the young were *E. gracilis* or *C. homei*, attention was turned to the morphology of the lower jaw, as illustrated by Arnold (*Bull. Brit. Mus. Nat. Hist. 4(6):256, 1956*). In *homei* the lower jaw is high posteriorly and bears a long bony ridge laterally, while in *gracilis* it is low posteriorly and lacks the ridge. My tenuis larvae have the jaw structure of *homei* and are referred to that species. That this is probably correct has been confirmed by D. C. Arnold (personal communication). The vexillifer, unfortunately, is damaged and cannot be identified as confidently. Its 203 anal rays fall within the 195–206 range found for adult *homei* rather than the 172–180 range found for adult *gracilis*, but it should be borne in mind that there is attrition of the tail tip in adults and these ranges may not be applicable to all size groups.

Fig. 1 shows the changes in gross morphology accompanying the transition from a pelagic to an inquiline mode of life for *C. homei*. Of note are the shrinkage in length, thickening in cross section, and increase in head size. A similar succession of events has been shown for *C. acus* by Padoa (*Pub. Staz. Zool. Napoli 20(2):111–21, 1947*).

Ecological data are available for the adults of three of the four species of Hawaiian Carapidae. Three *Encheliophis gracilis*, 192–237 mm in length, were obtained from the common sea cucumber, *Holothuria atra*. Two fish had gorged on the gonads of their hosts, the viscera of which were otherwise intact, while the third fish contained nothing in its stomach and was found in an eviscerated host. It appeared that the fish fed by swallowing the free ends of the attenuate gonad and working forward to the attached base. Parasitism on host gonads may be a general phenomenon for those species inhabiting holothurians, as it has been recorded for *Carapus acus* (Arnold, *Pub. Staz. Zool. Napoli 24(2):160, 1953*). It cannot be a serious menace to the Hawaiian sea cucumber population, however, for *H. atra* is common on reefs whereas pearlfish are rare. Of 122 holothurians (114 *H. atra*, 4 *H. cinerascens*, and 4 *Actinopyga mauritiana*) dissected by the writer, only two contained fish. Dr. S. J. Townsley, University of Hawaii, has informed me that he found no pearlfish in 702 sea cucumbers palpated, but not dissected, in a search for commensal crabs. Of this total, 433 were *atra*, 208 were *mauritiana*, 8 were *cinerascens*, and the balance represented seven less common species. A similar paucity of pearlfish has been noted by Parker (*Proc. Nat. Acad. Sci. Wash. 12(7):421–2, 1926*) and Aronson and Mosher (*Anat. Rec. 111(3):489, 1951*) for the Florida-Bahamas region.

Four *Carapus homei*, 80–121 mm in length,

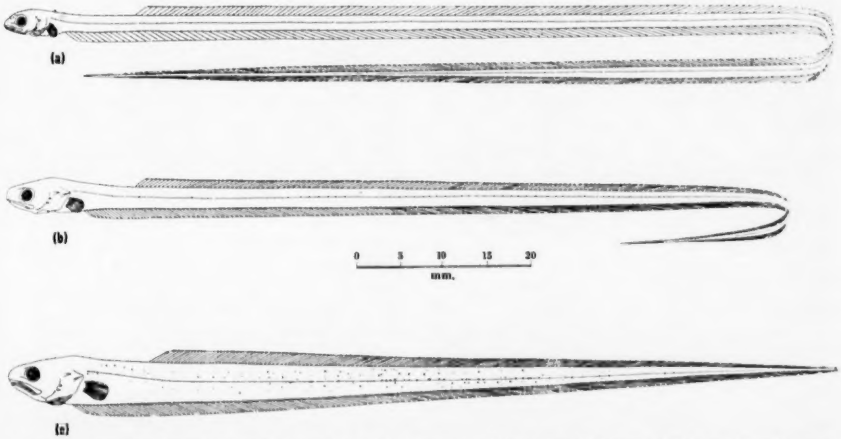


Fig. 1. Larval and juvenile stages of *Carapus homei*. (a) 200 mm. tenuis larva from high seas, (b) 120 mm. juvenile from *Culcita*, (c) 97 mm. juvenile from *Culcita*. The small protuberance anterior to the dorsal fin of the tenuis larva is the persistent vexillum base.

were removed from the body cavities of cushion stars, *Culcita novaeguineae*. In contrast to the hosts of *E. gracilis*, which were obtained at depths of 1–6 feet, the starfish harboring *C. homei* were collected at 40–70 feet. The starfish were not abundant and were not systematically sampled for pearlfish, but it was noted that two fish sometimes occupied the same starfish. The stomachs of these inquiline *homei* were empty. The tenuis and vexillifer larvae of *homei* mentioned above were captured within 450 feet of the surface in water 8000 feet deep, the time of day being 8–10 P.M. Thus, contrary to Arnold's statement (1956), these larvae were epipelagic rather than benthic.

Four *Carapus margaritiferae*, 60–73 mm in length, were available for study. One was found among the viscera of the rock oyster *Chama iostoma*, another from an unspecified oyster, and host data are not available for the other two. None contained food in the digestive tract, so that the diet of this remarkably toothed species remains unknown.—Donald W. Strasburg, *United States Department of the Interior, Bureau of Commercial Fisheries Biological Laboratory, Honolulu, Hawaii.*

FIRST RECORD FOR THE HAMMERHEAD SHARK, *SPHYRNA TUDES*, IN UNITED STATES WATERS.—On Feb. 16, 1958, eight specimens of *Sphyrna tudes* were collected by the M/V OREGON, at a depth of about 40 feet, in the northern Gulf of Mexico. The collection station (no. 2110) is located at 29°54′N, 88°06′W, only a short distance off the coast of Mississippi. The specimens are large juveniles and are nearly equal in size, measuring slightly over 400 mm in total length. All are catalogued as no. 195957 in the collection of the United States National Museum.

Sphyrna tudes has, until now, been known only from the southern Caribbean, from the coast of South America (as far south as Uruguay), and from the western Mediterranean (Nice and Livorno). The occurrence of this species in the Gulf of Mexico thus represents a significant range extension, as well as the first record from United States waters.

The nomenclature of *Sphyrna tudes* has recently been clarified by Tortonese (1950, *Ann. & Mag. Nat. Hist. ser. 12, vol. 3:1030–3*), who found that the syntypes of this species, in the Paris Museum (register nos. 1019 and 1049), are identical with the form described by Springer (1944, *J. Wash. Acad. Sci. 34:274–6*) as *Sphyrna bigelowi*, rather than with the great hammerhead (1960, *Am. Fish. Soc. special pub. 2:7*), which is the species to which the specific name *tudes* has been applied by Bigelow and Schroeder (1948, *Mem. Sears Found. Mar. Res. 1(1):428–36*) and others. The correct name for the great hammerhead should be *Sphyrna mokarran;* the vernacular name smalleye hammerhead is proposed for *Sphyrna tudes*.—Carter R. Gilbert, Department of Biology, *University of Florida, Gainesville, Florida.*

NOTES ON AND ADDITIONS TO THE FISH FAUNA OF THE TAMPA BAY AREA IN FLORIDA.—Springer and Woodburn (*1960. Fla. St. Bd. Conserv. Mar. Lab. Prof. Pap. Ser. 1:1–104*) published a study of the Tampa Bay area fishes. One of the purposes of their paper was to compile a list of the species known from that area. The total numbered 253. The purpose of the present note is to list additional species which have come to light since their publication, and to note other relevant facts on those already reported. The additions to the fish fauna noted herein bring the total for the area to 271 species. Unless indicated otherwise specimens upon which the records are based are deposited in the laboratory collections. Lengths are indicated as T.L. = total length, and S.L. = standard length.

It is again my privilege to extend to John H. Hurlbut, Marine Arena, Madeira Beach, my sincere appreciation for his constant efforts in obtaining and saving for me any rare and unusual fishes which have come to his attention. Other acknowledgments are made below.

Mustelus norrisi Springer. Several specimens were taken a short distance west of Johns Pass, Madeira Beach, during late January, 1961. One female, 964 mm T.L., caught on January 28 at a depth of 40 feet (approximately 10 miles west of Johns Pass) was pregnant. The heads of the placentated late stage embryos were all directed anteriorly in the two uteri. There were three males (260–268 mm T.L.) and three females (250–262 mm T.L.) in the right uterus and three females (185–262 mm T.L.) and five males (238–252 mm T.L.) in the left uterus. These embryos differed from the mother most conspicuously in having the lower lobe of the caudal fin poorly developed and rounded instead of strongly developed and pointed. Since the main character for separating *M. canis* from *M. norrisi* is the rounded lower caudal lobe in the former it would appear that the young of either species could be mistaken for the other.

The color of the embryos differed from the mother primarily in having large black blotches at the tips of both dorsal fins and the dorsal

caudal lobe. In the mother there was a slight blackening of the tip of the second dorsal fin only.

Eulamia milberti (Müller and Henle). No specimens are known to have been collected in the Tampa Bay area *per se*, but Springer (*1960. Fish. Bull. Fish & Wildl. Serv. 61, 178:1–38*) stated that the species is known from as far north as Tarpon Springs on the Florida west coast and mentions Tampa as a site where the species is abundant in depths less than 30 fathoms. He (personal communication) informed me that the species should be taken in brackish water in the Tampa Bay area during August. South of the Tampa Bay area (as defined by Springer and Woodburn *op. cit.*) his closest records were for Cortez, less than five miles away.

Eulamia floridana (Bigelow, Schroeder, and Springer). Two specimens, one each on December 24 and 25, 1960, were stranded alive on sandbars in Boca Ciega Bay. Both were females and neither was ripe. They measured 10 feet 2 inches and 10 feet 10 inches respectively. Verification of identification was made on the basis of measurements and tooth counts. Andrew McErlean, my associate, kindly obtained the jaws of both specimens (retained) and measurements on the larger. Stewart Springer informs me that these are the only inshore records of this species known to him and that the larger constitutes a size record.

Negaprion brevirostris (Poey). Although reported by Bigelow and Schroeder (*1948. Sears Found. Marine Res. Mem. 1(1):314*) as occurring commonly as far north as Tampa and Pensacola, the first actual record I know of is an immature male, 629 mm T.L., dip netted under a night light at Johns Pass during late June, 1960. A photograph in the St. Petersburg Times for July 28, 1959, shows two large specimens caught offshore locally.

Sphyrna lewini (Griffith). An immature female, 846 mm T.L., caught on March 28, 1961, at Indian Rocks Beach, is the first specimen I have identified from the area. The specimen was brought to my attention by Conservation Agent E. R. Harding.

Acipenser (probably *oxyrhynchus*). Townsend (*1902. U.S. Comm. Fish and Fish. Comm. Rept. 27(1901):155*) made the following statement: "The catch in Tampa Bay . . . during the winter of 1886 and 1887 was about 1500 sturgeon . . . The following season 2000 fish were secured . . . The next season only seven fish were taken and the fishery was then abandoned."

An occasional specimen is perhaps still taken in the area, but the most recent record I can find is a verbal one of a specimen caught at Johns Pass about 1952. It was exhibited by J. Hurlbut for a few days before it died.

Dorosoma cepedianum (LeSueur). One specimen, 218 mm S.L., taken in a cast net by Lewis Bender on January 1, 1961, off Weedon Island, Tampa Bay, is the first and only specimen I know of from the area.

Letharchus velifer Goode and Bean. Jordan and Evermann (*1896. Bull. U.S. Nat. Mus. 47(2): 375*) stated that this species was known from the snapper banks off Pensacola and Tampa. Ginsburg (*1951. Tex. Journ. Sci. 3(3):431–85*) who reviewed the genus did not note specimens from off Tampa and I know of none.

Hemiramphus brasiliensis (Linnaeus). Several specimens were taken with a dip net during March and April, 1960, beneath a night light at Johns Pass.

Regalecus glesne (Ascanius). Three specimens, all alive, were taken March 24, 25 and 26, 1960, on the Gulf beaches in the Tampa Bay area. Hutton (*Bull. Mar. Sci. Gulf and Carib. in press*) will report on the details of their occurrence. One of the specimens has been deposited in the collections of the University of Miami Marine Laboratory.

Etheostoma fusiforme (Girard). Dr. Bruce Collette has informed me that there is a specimen in the Cornell University collections, collected June 20, 1948, from a pond four miles northeast of Dunedin.

Epinephelus drummondhayi Goode and Bean. This species is occasionally taken by party boats fishing in water at depths of at least 20 fathoms west of Johns Pass. It is called "guinea grouper" by the commercial fishermen. There is one specimen in our collections taken July 11, 1960, about 70 miles west of Johns Pass in 25 fathoms.

Vomer setapinnis (Mitchill). A single specimen, 175 mm S.L., caught March 23, 1961, in Boca Ciega Bay off Pass-a-Grille is the only record for the species in the area.

Haemulon flavolineatum (Desmarest). Walter Courtenay has informed me that the holotype of *Haemulon fremebundum* Goode and Bean from Clearwater is a young specimen of *H. flavolineatum*. The presence of *H. macrostomum* in the Tampa Bay area (Springer and Woodburn *op. cit.*) was based on Jordan and Fesler's (1893. *U.S. Comm. Fish & Fish. Comm. Rept. 17 (1889–1891):470*) erroneus synonymy of *H. fremebundum* with that species.

Diplodus holbrooki (Bean). Springer and Woodburn (*op. cit.*) erroneously reported Caldwell (*1955. Quart. Journ. Fla. Acad. Sci. 18(2): 73–83*) as stating that the normal southern dis-

tribution of this species on the Florida west coast was Cedar Key, whereas Caldwell stated that Cedar Key was the normal northern limit.

Kyphosus sectatrix (Linnaeus). Several specimens were caught in Boca Ciega Bay during late December, 1959. These are the first local records known to me since the report by Henshall (*1895. Bull. U.S. Fish Comm. 14(1894):218*).

Acanthocybium solanderi (Cuvier). The St. Petersburg Times for July 16, 1959, carries a photograph of a 16.5 pound wahoo caught 25 miles west of Anna Maria. An accompanying story stated that another specimen was caught in shallow water on St. Petersburg Beach several years ago by either netting or clubbing.

Thunnus atlanticus (Lesson). Springer and Woodburn (*op. cit.*) reported this species on the basis of a color slide. Since that time I have examined several large specimens (one, a 33.5 pound specimen, is preserved in the University of Miami Ichthyological Collection) caught offshore locally. Luis Rivas has examined the original color slide and (personal communication) believes that the specimen might be a *Thunnus albacares*. His major objection to the original identification was that the size was too large, but this has been excluded by the appearance of the large specimen mentioned above.

Coryphopterus punctipectophorus Springer. This species was reported as *Coryphopterus* sp. by Springer and Woodburn (*op. cit.*).

Evermannichthys spongicola (Radcliffe). Delsman (*1941. Mem. Mus. Royal Hist. Nat. Belg. ser. 2, fasc. 21:76*) reported collecting nine specimens, 17–27 mm, seven to 10 miles off Tampa Bay at a depth of eight to 10 fathoms. It is interesting to note that this is the only species he lists from the area. I know of no other local records.

Gobiosoma longipala Ginsburg. A single specimen, 14.9 mm S.L., was collected with a push net at the Tampa Bay station (Springer and Woodburn *op. cit.*) on November 22, 1960 (salinity, 22.8 ppm; temperature 25.0°C; depth, 0.5 meter). This is the first record of this species north of Marco, Florida.

Microdesmus sp. Two specimens (165 mm S.L., March, 1960, Johns Pass, and 141 mm S.L., August, 1959, St. Petersburg Beach) have been obtained. C. E. Dawson, who is studying the genus, has informed me that they may represent a new subspecies of *M. longipinnis*.

Starksia ocellata (Steindachner). This species was reported as *Brannerella sp.* by Springer and Woodburn (*op. cit.*).

Poronotus triacanthus (Peck). A single specimen, 45.5 mm S.L., taken beneath a night light at Johns Pass during February, 1960, is the only record of this species for the area.

Peprilus alepidotus (Linnaeus). Several subadult specimens were taken at Johns Pass under a night light on April 25, 1960. These are the first local records known to me since Jordan (*1885. Proc. Acad. Nat. Sci. Philad. 1884, 42:45*) reported the species from Egmont Key. The young of this species have frequently been misidentified as *Poronotus triacanthus*. This has been due to the fact that *Peprilus* is described as lacking pores along the back (for an exception see *Peprilus burti* Fowler, *1944. Notulae Naturae 142:1–4*). The young of both *P. alepidotus* and *P. triacanthus* have numerous pores along the dorsal portions of the sides. These pores are absent in adults of the former, but are retained in the latter.

Gymnachirus williamsoni (Gunter). Gunter (*1939. Copeia (4):188–93*) reported on four specimens in the collections of the University of Michigan which were collected in Boca Ciega Bay. I know of no other local collections.

Remora remora (Linnaeus). A specimen was taken off a sailfish caught about 25 miles west of St. Petersburg Beach on August 19, 1960. A second specimen was taken off a female *Eulamia floridana* (see above) taken in Boca Ciega Bay on December 24, 1960. In addition to this latter specimen there were several *Echeneis naucrates* on the shark also.—Victor G. Springer, *Florida State Board of Conservation Marine Laboratory, St. Petersburg.* Contribution No. 52.

AN ALBINO COWNOSE RAY, *RHINOPTERA BONASUS* (MITCHILL) FROM CHESAPEAKE BAY.—Fishes displaying albinism or at least partial albinism have been reported from a number of families and genera. This phenomenon is relatively common in some groups, the Heterosomata for example, but the lack of records would indicate that it is quite rare among others, especially the elasmobranchs.

In May of 1960, the Virginia Fisheries Laboratory was informed by the Chesapeake Seafood Corporation of New Point, Virginia, that a white stingray had been captured in a local pound net. The stingray was an adult female cownose ray, *Rhinoptera bonasus* (Mitchill) 1815, approximately 35 inches in disc width.

The dorsal surface, normally a dark chocolate brown, was completely devoid of pigment and indistinguishable in color from the ventral surface, which is always white. Pigment was limited to the irises of the eyes, which were light brown.

When the body cavity of the ray was opened,

a normally colored and fully developed male embryo was found. The embryo was 13 inches in disc width, which is the approximate size at birth (Bigelow and Schroeder, 1923, *Yale Univ., Sears Found. Mem. 1(2):469*). The albino female and normally pigmented embryo are illustrated in Fig. 1.

Mr. William Burroughs, caught the stingray in a pound net set in 30 feet of water on May 23, 1960. The site of the net was four miles ESE of Horn Harbor, north of Mobjack Bay on the western shore of Chesapeake Bay.

This is the second record of a white cownose ray from Chesapeake Bay. The first, a mature male, was caught in Tangier Sound in May of 1959 (Schwartz, 1959, *Maryland Tidewater News, 15(3):12*).

This species was not seen by Hildebrand and Schroeder (1928, *Bull. U. S. Bur. Fish. 43(1):71*), but they stated that although previously recorded from Chesapeake Bay it is evidently very rare. Most records of occurrence of this ray along the Atlantic coast are based on a single specimen or at most a few individuals. On occasion, however, large inshore incursions have been recorded. Bigelow and Schroeder (*ibid., p. 474*) summarized documented incursions reported since 1815 along the Atlantic coast of the United States. The entry containing the highest specific number was a record of 145 cownose rays taken in a single day by an unspecified number of pounds nets in the vicinity of Woods Hole, Massachusetts.

During the spring and early summer of 1960, cownose rays were present in lower Chesapeake Bay in unusual numbers. The same fisherman who caught the albino ray reported their numbers in two pound nets fished several days earlier. From one net 330 rays were removed. The weight of the entrapped rays in a second net was too great to permit the net to be lifted, thus is was necessary to lower the net and allow them to escape. The number of rays in this net was estimated at about 600.

A number of fishermen in the area were consulted to determine whether such abundance had been encountered in past seasons and to learn if other albinos had been sighted. Most of the fishermen had many years experience in local waters, but none could recall such concentrations in the past, nor ever having seen a colorless member of any of the several species of rays which are common to this area.

The lack of records of albinism among the elasmobranch fishes is not surprising in view of the low numbers which are actually observed compared to numbers of bony fishes which are regularly sought on a commercial scale.—EDWIN

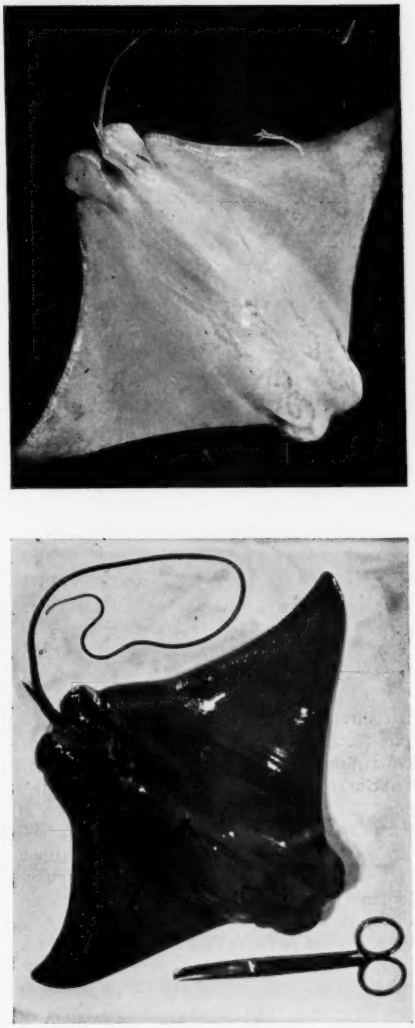


Fig. 1. [Upper] Adult albino female cownose ray, *Rhinoptera bonasus*, and [lower] normally pigmented male embryo.

B. JOSEPH, *Virginia Fisheries Laboratory, Gloucester Point, Virginia.* Virginia Fisheries Laboratory Contribution No. 103.

A NEW LONGEVITY RECORD FOR THE LANDLOCKED POPULATION OF *SALMO SALAR*.—A female landlocked salmon, *Salmo salar*, tagged on the spawning run in November, 1955, was recaptured by an angler in June, 1960,

in Long Lake, Aroostook County, Maine. Scale examination at tagging revealed eight clear annuli (age VIII+). No scales were available for study at the time of recapture, but assuming the original aging to be accurate, the salmon would have been age XIII+ in 1960, establishing a new longevity record.

The salmon was 28 inches in total length and weighed 7.1 pounds at recapture and had grown very little since tagging 5 years previously. Known spawning history and spawning checks on the scales indicated that the salmon had spawned three times prior to 1956, at ages IV+, VI+, and VIII+.

Previously, the oldest landlocked salmon on record was a female, weighing 19.7 pounds, taken by an angler in Long Lake in 1941. This salmon was aged by scale reading as XI+ (Everhart, 1958, *Fishes of Maine. Maine Dept. Inland Fish. & Game, Augusta, 2nd edit: 32*).—KENDALL WARNER, *Maine Department of Inland Fisheries and Game, Augusta, Maine.*

RANGE EXTENSION OF THE TEMPERATE BLENNIOID FISH, *NEOCLINUS BRYOPE*, INTO THE TROPICAL WESTERN PACIFIC.—The fishes of the genus *Neoclinus* were recently revised by Clark Hubbs (*Copeia 1:11–23*, 1953). This genus has previously been considered strictly an element of the temperate North Pacific. During the summer of 1960, while working on contract research at the U. S. National Museum (Contract AT (30-1) 2409, A.E.C., Environmental Science Branch, Division of Biology and Medicine), I discovered two specimens of this genus that were collected by James R. Simon at Okinawa in 1945. These two specimens do not appear to be specifically or subspecifically distinct from Japanese specimens of *Neoclinus bryope* (Jordan and Snyder). This is, however, a considerable range extension of this species.

The specimens of *Neoclinus bryope* from Okinawa, USNM 132808 and 195823, fit generally into the description of the species as presented by Hubbs (1953). The following description deals only with those characteristics which seem to be at variance with this description. All variations observed seem to fall well within the range of variability of the Japanese species. Both specimens are in excellent condition.

The most significant variation of the Okinawan specimens is the degree of squamation. All specimens of *bryope* from Japan are heavily scaled on the body between the pectoral fin and the caudal peduncle. In the Okinawan specimens, scales are extremely difficult to observe and are imbedded. The Okinawan specimens are not large, 37.8 and 36.6 mm in standard length, but Japanese specimens of equal size or even smaller have well developed scales. The scales are identical in shape and size at all locations on the body. This difference in squamation might well be considered of specific value but *Neoclinus stephensae* Hubbs, shows a similar variation in scalation.

The color pattern of the Okinawan specimens (Fig. 1) is also somewhat distinct. All specimens of *bryope* from Japan that I have examined are either of the barred or plain color phase and the Okinawan specimens are somewhat intermediate between these two conditions. Hubbs, however, states that all stages of integration between these two phases are present in the Japanese species.

The fin counts: dorsal XXIV–XXV, 16; anal II, 28–29; pectoral 13, pelvic I, 3, caudal 13 are inclusive within the range of counts listed by Hubbs. Only the pectoral count may be significant as the majority of the Japanese specimens have 14 pectoral rays.

The distribution of *Neoclinus bryope* as recorded by Jordan and Snyder (*Proc. U. S. Nat. Mus. 25(1293):448–50*, 1903) and Hubbs (1953) includes only three localities: Misaki, Wakanoura, and Enoura, Japan. The first two localities are on the Island of Honshu between 34 and 35 degrees north latitude. The third locality, Enoura, or Eno Ura (the bay of Eno) is not specific as there are three localities in Japan with this designation; two on the Island of Kyushu at the southern tip of Japan and the third on Honshu near the other described localities. It seems reasonable that Jordan and Snyder were referring to the Honshu locality. The Okinawan specimens are from Kimmu Wan Bay, Okinawa, approximately 26°20′ north latitude.

All species of the genus *Neoclinus* from California, *blanchardi* Girard, *uninotatus* Hubbs, and *stephensae* Hubbs, are temperate forms ranging from San Martin Island off the north coast of Baja California to Monterey or San Francisco, California. They are part of the San Diegan fauna which is restricted to the north by the cold temperate waters and to the south by the northern extension of the tropical Panamanian fauna. The Japanese species *bryope* was considered by Hubbs to be temperate but was said to inhabit warm, clear tidepools. Okinawa, however, is a tropical locality.

The genus *Neoclinus*, which I consider as part of the Clinidae, probably arose in the New World tropics. The family Chaenopsidae (Emblemariidae + Chaenopsidae) arose as an offshoot from this primitive stock. *Neoclinus* has since migrated or been displaced from the New World tropics and now occupies the above mentioned temperate or subtropical San Diegan region. One species, *bryope*, probably migrated to Japan during a

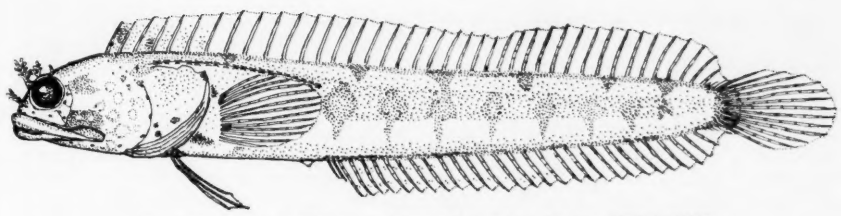


Fig. 1. *Neoclinus bryope*, 36.8 mm in Standard Length from Okinawa; USNM 132808.

warm interglacial period (Hubbs, *Stanford Ich. Bull. 4(2):52*, 1952). This species now seems to have extended its range southward into the tropics of the Western Pacific. It is of interest that this hypothetical temporal change in the distribution of the genus involves two independent movements between tropical and temperate waters. If such a movement has been possible in the past and/or is occurring presently in the Western Pacific, why does the southern boundary of the genus in the Eastern Pacific approximate the southern limit of the temperate waters? I believe that the answer to this question can be found in habitat preference and competition rather than water temperature. The chaenopsids and *Neoclinus* occupy the same habitat, living primarily in warm tubes and mollusk shells of the intertidal-subtidal zone. In the Eastern Pacific, the northern limit of the chaenopsids and the southern limit of *Neoclinus* are in close approximation. It would seem possible, therefore, that the present distribution of these two groups represents the displacement of the ancestral form (*Neoclinus*) from its place of origin by a related and possibly better adapted group (Chaenopsidae). Such a displacement is well documented by Darlington (Zoogeography; *John Wiley & Sons: 675 pp.* 1957) for other "cold blooded" vertebrate groups. If this is the situation in the Eastern Pacific, it is somewhat surprising that transgression into the tropic can occur in the Western Pacific, the home of the tropical blennies.—JOHN STEPHENS, *Department of Biology, Occidental College.*

IS FLATFISH ASYMMETRY TRANSMITTED CYTOPLASMICALLY?—It is highly probable that in flatfishes (Pleuronectiformes) the side of the body to which the eye migrates is genetically determined. Concerning this, Hubbs and Hubbs (1945, *Pap. Mich. Acad. Sci., Arts, and Let. 30:247*) wrote: "... The production of rights and lefts in approximately equal numbers, in the hybrids derived from the natural crossing of the dextral species *Kareius bicoloratus* and the invariably sinistral Japanese races of *Platichthys stellatus* (Hubbs and Kuronuma, 1942:300), suggests strongly that simple genetic factors are involved in determining whether a flounder be left-eyed or right-eyed. There is no evidence that cytoplasmic inheritance is operative in the development of flatfish asymmetry...." Hubbs and Kuronuma (1942, *Pap. Mich. Acad. Sci., Arts, and Let. 27:267–306*) had 27 natural hybrids, 14 sinistral and 13 dextral. There is no information available on how handedness is determined in either of the parental species and it is unsafe to assume that the identical gene loci are involved in both. In addition it is now known that Japanese *P. stellatus* are not invariably sinistral (Orcutt, 1950, *Calif. Fish & Game Div. Bur. Mar. Fish. Fish Bull. 78:1–64*).

Although Hubbs and Hubbs believed there is no evidence for cytoplasmic inheritance of flatfish asymmetry, the natural hybrid data may be interpreted as a possible example of either maternal influence or cytoplasmic inheritance. The former is a fairly common phenomenon, and has been demonstrated in the threespine stickleback. Heuts (1947, *Evolution 1:89–102*) found that on crossing marine and freshwater races of *Gasterosteus aculeatus* the hatching requirements of the hybrid eggs depend upon the race of the mother; if the mother were of the marine race the hybrid eggs hatched best in salt water, and if of the freshwater race they hatched best in fresh water.

Returning to the hybrid Japanese flounders, there is no evidence they were produced from only one kind of cross. Two kinds of matings could have produced the hybrids, as follows: 1) sinistral female *P. stellatus* X dextral male *K. bicoloratus*, 2) dextral female *K. bicoloratus* X sinistral male *P. stellatus*. Since dextral *P. stellatus* are rare in Japanese waters, crosses involving them are not considered. The maternal parent's ova contain practically all of the cytoplasm entering into the zygotes; thus in cases of cytoplasmic inheritance and maternal influence the offspring's characteristics are determined by the maternal parent. If both kinds of matings occur with equal frequency (assuming equal sex frequencies in the parental species) then half of the hybrids will be dextral and half will be sinistral, provided that sidedness is influenced through the

cytoplasm. Significantly, Hubbs and Kuronuma found 13 dextral and 14 sinistral hybrid fish, which supports the hypothesis that sidedness is maternally influenced or inherited cytoplasmically.

It is apparent that if sidedness is maternally influenced in these flounders then the phenotype of the individual gives no clue to its genotype but rather gives a clue to the genotype of the mother. If cytoplasmic inheritance is operative, then the individual's genotype will determine its phenotype. However, Hubbs and Kuronuma's data may reflect a threshold phenomenon. Thus their data may indicate maternal influence, cytoplasmic inheritance, a threshold effect, or some other influence not considered here. In any event although simple genetic factors may be involved in determining whether a flounder be left-eyed or right-eyed, other possibilities are not excluded on the basis of the natural hybrid data.

It would be interesting to conduct breeding experiments involving dextral and sinistral *P. stellatus*, both of which are found along the Pacific coast of North America, to ascertain how sidedness may be transmitted from one generation to the next. It may not be essential to rear the young to the completion of metamorphosis, since careful histological study may reveal that the future asymmetry can be determined long before the eye undertakes its migration.—VLADIMIR WALTERS, *Department of Zoology, University of California. Los Angeles.*

Herpetological Notes

THE REPTILES OF THE LUND UNIVERSITY CHILE EXPEDITION.—The collection of reptiles made in Chile by the Lund University Chile Expedition 1948–1949 is composed of ten species, one of which represents a new geographical race.

For the purpose of maintaining a certain uniformity, I have followed in general the scheme adopted by Schmidt (1954, *Lund Univ. Arskr., new series, sect. 2, vol. 49, no. 19: 1–6*) for the study of amphibians obtained by the same expedition.

List of collecting stations: (Brattström and Dahl, 1952, ibid., vol. 46, no. 8:1–88)

Sta. L4.—Prov. de Llanquihue, Dept. de Puerto Varas, Esteron Pichi-Pilluco. Near the sea. Altitude 0–0.5 m. Small water holes between thickets. 41°27′S/72°55′W. 28-X-1948.

Sta. T7.—Prov. de Chiloé, Dept. de Ancud, Isla de Chiloe, south of Lechagua. Altitude 100–200 m. Forest paths and clearings. 41°53′S/73°52′W. 18-XI-48.

Sta. T16.—Prov. de Llanguihue, Dept. de Puerto Varas, Petrohué. At the western end of Lago todos los Santos. 41°07′S/73°23′W. 26-XII-48.

Sta. T19.—Prov. de Llanquihue, Dept. de Calbuco, Isla Calbuco (San Antonio). Near the town Calbuco. Under tree trunks and stones and on plants. 41°46′S/73°08′W. 28-XII-48.

Sta. T20.—Prov. de Llanquihue, Dept. de Llanquihue, Estero Pichi-Pilluco, east of Puerto Montt. Near the sea. Altitude 30 m. Along shore of small lake. 41°28′S/72°56′W. 11-III-49.

Sta. T24.—Prov. de Chiloé, Dept. de Ancud, Punta el Morro SW of Ancud. Altitude 0–15 m. Sea shore with rocks and sand. 41°53′S/73°51′W. 2-III-49.

Sta. T26.—Prov. de Chiloé, Dept. de Ancud, Isla Chiloe, Estero Pudeto, east of Cerro Hueihuin. Altitude 0–1 m. 41°52′S/73°49′W. 4-III-49.

Sta. T27.—Same as Sta. T7. 1-I-49.

Sta. T29.—Prov. de Coquimbo, Coquimbo Peninsula, northwest of Guayacan. Altitude 100 m. Sand plains with boulders. Sparse vegetation of torch thistles and thorny shrubs. 29°58′S/71°22′W. 21-VI-49.

Sta. T32.—Prov. de Coquimbo, Coquimbo Peninsula, promontory south of Roca Pelicanos, north of Coquimbo. Altitude 0–40 m. Rocks and sandy areas with boulders. 29°56′S/71°21′W. 23-VI-49.

Sta. T33.—Prov. de Coquimbo, Valle Elqui near Vicuña. Arid cactaceous plain, stones and sand. 30°02′S/69°36′W. 22-VI-49.

Sta. T34.—Prov. de Tarapacá, Iquique and surroundings. Altitude 0–10 m. 20°13′S/70°10′W. 30-VI-49.

Iguanidae

Liolaemus pictus pictus (Duméril and Bibron) Sta. T16—3 adults, 1 young. L4—one specimen.

Liolaemus pictus chiloensis Müller and Hellmich Sta. T24—2 adult females. T27—8 specimens.

Liolaemus cyanogaster brattstroemi *subsp. n.* (Fig. 1)

Holotype: Adult female (forest near Lechagua) T7.

Paratype: Young female (Lechagua forest) T7.

Diagnosis: L. c. brattstroemi differs from the nominal form *L. c. cyanogaster* in the smooth

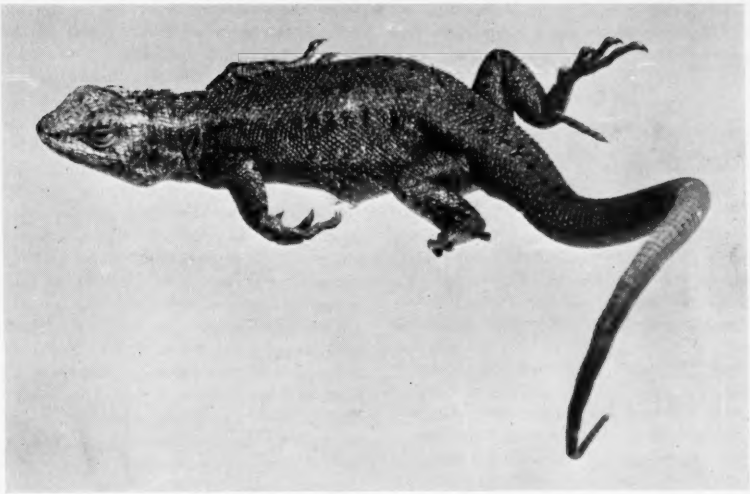


Fig. 1 *Liolaemus cyanogaster brattstroemi* R. Donoso-Barros. Holotype (adult female) Sta. T7, forest near Lechagua, Chiloé Island.

temporal scales, the rounded dorsal scales, and the greater number of scales around the middle of the body.

Description.—Habitus robust. Medium size. Head short, nostril antero-lateral. Upper head scales rather large, smooth. Two azygous frontals, separated from the interparietal by a pair of frontoparietals of the same size. Interparietals smaller than parietals. A series of four small supraoculars transversely dilated. Temporal scales not keeled. Infraorbital long. A single series of scales between labials and the infraorbitals. Ear opening smooth, without auricular scales. Dorsal scales rounded, flattened, slightly keeled. Ventral scales rounded and smooth. Caudal scales of the same size as dorsals, with the keels more accentuated, diagonally oriented. Limb scales of the same size as dorsals. Sixty scales around the middle of body. Adpressed hind limb reaches the axilla. Tail about two times as long as head and body.

Brown-olive on the back. Two pale supraocular bands, bordered by black spots. Flanks dark brown with many small black spots. Ventral regions light sky blue with small black spots. Tail olive-brown, dorsal parts with black spots arranged in one row in the proximal third.

Paratype.—Thinner and more delicate than the type. Antehumeral fold not very pronounced. Dorsal scales weakly keeled. Middle of body with 58 scales. Dorsus brown-olive, darker than holotype. White supraocular bands medially split by another line of small black points. Lateral parts of the sides are brown with some sky blue tones in the mandibular region. Measurements in Table 1.

Table 1. Measurements (mm) of Holotype and Paratype of *Liolamus cyanogaster brattstroemi* subsp. n.

	Type	Paratype
Head and body	60	55
Tail	100	83
Head	15	12
Forelimb	26	22
Hind limb	37	32

Liolaemus platei platei Werner
Sta. T33—a young specimen.

Liolaemus nigromaculatus kuhlmani Müller and Hellmich
Sta. T32—an adult male.

Liolaemus nigromaculatus atacamensis Müller and Hellmich
Sta. T29—1 adult male, 2 adult females, 3 juveniles. The sex dimorphism is very distinctive in this geographic form.

Tropidurus peruvianus quadrivittata (Tschudi)
Sta. T34—a young specimen.

Colubridae

Tachymenis peruviana assimilis (Jan)
Sta. T33—a young specimen.

Tachymenis peruviana melanura Walker
Sta. T19—1 specimen. T20—1 specimen. Collected among bushes and grass.

Dromicus chamissonis (Wiegmann)

An adult from Pichidangui, Coquimbo. Collected 15-II-51 by the author.

RESUMEN

Las especies de reptiles recogidas por la Expedición de la Universidad de Lund en Chile son:

Liolaemus pictus pictus (Duméril y Bibron) de la Provincia de Llanquihue

Liolaemus pictus chiloensis Müller y Hellmich de la Isla de Chiloé (Ancud)

Liolaemus cyanogaster brattstroemi Donoso-Barros subsp.n. de los bosques de Lechagua, Isla de Chiloé

Liolaemus platei platei Werner del Valle de Elqui.

Liolaemus nigromaculatus kuhlmani Müller y Hellmich de la Península de Coquimbo

Liolaemus nigromaculatus atacamensis Müller y Hellmuch al nomeste de la Península de Coquimbo

Tropidurus peruvianus quadrivittata (Tschudi) característico de Iquique

Tachymenis peruviana assimilis (Jan) de la region centrochilena.

Tachymenis peruviana melanura (Walker) de las islas del Archipiélago de Chiloé y de algunas zonas del sur de Chile.

Dromicus chamissonis (Wiegmann) de la región centrochilena.—R. DONOSO-BARROS, *Instituto Biologia, University of Chile, Santiago, Chile.*

WATER LEVELS AS AN ENVIRONMENTAL FACTOR IN THE BREEDING SEASON OF *BUFO BOREAS BOREAS* (BAIRD AND GIRARD).—General accounts of western amphibians list the breeding season of *Bufo b. boreas* as extending from January through July, the breeding season being later in areas of higher altitudes and latitudes. Factors, other than temperature, which influence the breeding season are seldom (if ever) mentioned. Along the Snake River canyon in eastern Washington and northwestern Idaho, water conditions play such an important role in determining the breeding season of *B. b. boreas* that temperature appears to have a negative correlation.

On the prairies of Whitman and Asotin counties, Washington and Latah County, Idaho, which range from 2000 to 2500 feet elevation, the breeding season of *boreas* generally varies from the last week of April to the middle of May. Development is rapid with transformation coming in August.

The deep canyon cut by the Snake River in this area (Lewiston, Idaho is elevation 738 feet) warms up much earlier than the surrounding prairies in the spring and is a great deal hotter in the summer. If temperature were the only factor influencing breeding in *Bufo b. boreas*, the toad would breed earlier in the Snake River canyon than on the nearby cooler prairies.

Such is not the case. For three summers (1958, 1959, 1960) I found large breeding colonies of *boreas* along the Snake River the first week of July. At the same time the toads were breeding in the sloughs along the Snake River, *boreas* tadpoles were already in the hindlimb stage in higher, cooler ponds on the prairie less than ten miles away.

The character of the Snake River offers a ready explanation for the toads' behavior. Due to its great length and large drainage, the Snake is at its highest level of runoff in Washington during May and June. The river begins to recede after the middle of June, and, by the first of July it is at a low level. Any toads attempting to breed before the spring runoff subsides would have their eggs and/or tadpoles washed away by the high swift water. Evidently this selection factor is quite strong, for no breeding toads can be found along the Snake River in early spring when they would be expected to be at the breeding sites.

What initiates this later breeding of *Bufo b. boreas* in the Snake canyon is not clear. Toads in the side canyons have no apparent way of knowing the spring runoff has subsided and it is time for them to move to the breeding sites along the river. It is difficult to imagine temperature initiating breeding within the canyon when the same species breeds two months earlier a few miles away in cooler locations.—DEAN E. METTER, *Department of Biology, University of Idaho, Moscow, Idaho.*

MICROELECTROPHORESIS AND IMMUNOELECTROPHORESIS OF SNAKE VENOMS[1]. Electrophoretic studies on snake venom, including the first analysis by von Klobusitzky and König (1939, *Arch. exptl. Pathol. Pharmakol. 192:271–275*), have been carried out with either the agar slide, the free boundary or the filter paper method. These procedures in general have serious disadvantages: they are either time consuming, require elaborate equipment, or result in poorly defined bands.

In the present study a recently developed technique for the microelectrophoresis and immunoelectrophoresis of serum proteins was adapted to the analysis of snake venom. It

[1] Aided by grants from the William E. Musgrave and the Alfred J. Gilbert Memorial Funds, allocated by the Committee on Research, University of California School of Medicine, and by grant No. A-3774, U. S. Public Health Service.

proved to be far more sensitive and to have higher powers of resolution than the previously described procedures.

Procedure

Microelectrophoresis was carried out on cellulose acetate membranes[2] as described by Grunbaum, Kirk and Atchley (1960, *Anal. Chem., 32:1361–1362*) and on filter paper for comparison, using an electrophoretic unit developed by Grunbaum and Kirk (1960, *Anal. Chem., 32:564–566*). The unit consists of a Plexiglass cell and a metal holder for the test strip.

With this method, about 0.5 μl of venom is applied to the test strip with a flattened platinum loop. Twenty volts per cm is applied for 1½ hours, after which the test strip is removed and dried in an oven at 110°C. for 5 minutes to fix the proteins. It is then floated, and finally immersed, in a 0.2 per cent solution of Ponceau S in 3 per cent trichloroacetic acid. After 5 minutes in the dye, the strip is removed, washed in 5 per cent acetic acid to remove excess stain until the background is clear, and dried again. The patterns are then graphed by a modified Spinco Analytrol densitometer (Grunbaum, Fessel and Piel, 1961, *Anal. Chem.*, 33:860–861).

Immunoelectrophoresis was performed according to the method of Grunbaum, Kirk and Piel (manuscript) as follows: The cellulose film is divided, by a longitudinal cut-out into a narrow and a wide strip. Samples of venom are applied to both strips, and electrophoresis is carried out as described before. After the current is turned off, the narrow strip is removed from the unit and stained; the broad strip is left in place. Antivenin [Antivenin (Crotalidae) Polyvalent, Wyeth] is applied with a fine pipette along each edge of the broad strip. The unit is then closed tightly and left undisturbed. After 48 hours, the strip is removed from the apparatus, washed in physiological saline for 30 to 120 minutes to remove antibody-antigen excess, dried and stained with Ponceau S. The narrow strip serves as a guide for locating protein bands: an immunophoretic curve corresponds to an electrophoretic band when the apex of the curve is directly in line with the band.

Analysis of Venom

Dried venom from *Crotalus adamanteus* and fresh venom from captive *Crotalus cerastes* and *Crotalus ruber* were used in this study.[3] The venoms were diluted with barbital buffers at pH 5.0 to 9.5. The solutions ranged from 4 to 25 per cent venom by weight.

Results and Discussion

Dilution of venom with buffers in the higher pH range gave wider separation of the various bands on cellulose acetate strips, but also wider and more diffuse bands. The reverse was true at lower pH values. Barbital buffer at pH 8.6 and ionic strength 0.075 resulted in optimal electrophoretic resolution. The concentration of venom was not critical, but best results were obtained with solutions in the range of 5 to 10 per cent.

As shown in Fig. 1, with cellulose acetate strips *C. adamanteus* venom was resolved into at least 7 bands, in sharp contrast to the single, possibly double, diffuse band obtained when filter paper was used as the supporting medium. Similarly ill-defined bands were obtained by electrophoresis of *C. adamanteus* venom on filter paper by Gonçalves (1956, *Venoms, American Association for Advancement of Science. Washington, D.C., pp. 261–274*). Use of the immunodiffusion technique following electrophoresis resulted in at least 13 bands (Fig. 2). These 13 correspond to the 7 on the electrophoretic strip plus at least 6 others. This finding suggests at least two alternate explanations: (1) some components present in low concentration are not visible when stained, but do yield adequate precipitates with strong antiserum, or (2) two components migrating at similar rates in an electric field, but having different precipitation maxima form separate lines on immunoelectrophoresis. The presence of antigen-antibody re-

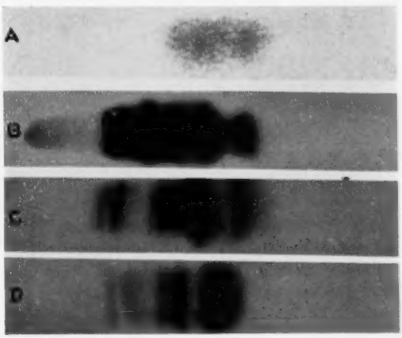


Fig. 1. Electrophoretic patterns of snake venoms: *C. adamanteus* on paper (A), *C. adamanteus* on cellulose acetate (B), *C. ruber* on cellulose acetate (C), *C. cerastes* on cellulose acetate (D). Cathode at left.

[2] Cellulose acetate film, Consolidated Laboratories, Chicago Heights, Ill.

[3] *Crotalus adamanteus* venom was obtained from Ross Allen's Reptile Institute, Siver Springs, Florida. Venom from *Crotalus cerastes* and *Crotalus ruber* was supplied through the courtesy of Dr. E. Herald, Dr. A. Leviton and Dr. B. Banta of the California Academy of Sciences.

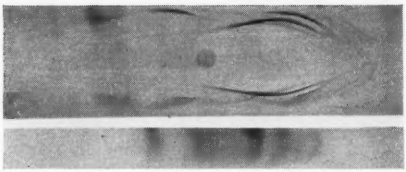


Fig. 2. Top: Immunoelectrophoretic pattern of *C. adamanteus* venom and polyvalent antivenin. Bottom: Electrophoretic pattern alone, serving as guide strip, and run simultaneously as shown.

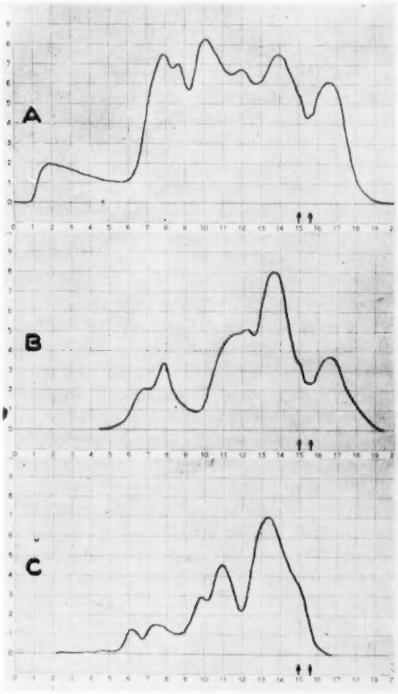


Fig. 3. Densitometric analyses of electrophoretic pattern of *C. adamanteus* (A), *C. ruber* (B) and *C. cerastes* (C). The point of application of venom is between the arrows. Cathodal migration to the left.

action results in a precipitin line, which can occur only if the two components are present.

The electrophoretic and densitometric patterns obtained by analysis of venom from *C. cerastes* and *C. ruber* differed markedly from each other and from that of *C. adamanteus* (Fig. 1 and 3).

Recently, Schenberg (1959, *Science, 129:1361–1363*) stated that the electrophoretic patterns of snake venom may be species specific, and thus could be useful in supplementing morphological data on taxonomy. Application of the electrophoretic technique described in this report to venom and other biological fluids should allow differentiation between many closely related species in the animal kingdom.

Acknowledgment. This study was carried out with the technical assistance of Luther Dong.

Summary

A recently developed method for the microelectrophoresis and immunoelectrophoresis of serum proteins was adapted to the analysis of snake venoms. The method has the advantage of being rapid and simple and of requiring only small amounts of venom. In addition, it resolves the venom into more numerous and more sharply defined bands than can be obtained with other procedures currently in use.—Walter G. Strauss and Benjamin W. Grunbaum, *The Departments of Medicine and Pediatrics, University of California School of Medicine, San Francisco, California*

THE FIRST RECORD OF EGG LAYING IN THE CAECILIAN *SIPHONOPS PAULENSIS* BOETTGER.—During the fall of 1960, I received two specimens of *Siphonops paulensis* Boettger from Mr. Eric J. Phillips of Primavera, Alto Paraguay, who had encountered them on a footpath during a morning after a rain. They were kept in a mixture of soil and peatmoss, through which they burrowed with facility. On 27 January, I removed one of the specimens to a small bowl to photograph it.

The specimen selected had been restless for several days and was wandering over the surface of the soil at the time it was removed. At 19:30 on 28 January, I noticed that it was extruding an egg from its cloaca. Examination of the soil disclosed that two other eggs had already been deposited. Three other eggs were extruded, one at 22:45, and the fifth and sixth at 02:45 and approximately 04:00 on 29 January.

The eggs measured 4.3 to 4.5 mm in diameter and were covered by a gelatinous capsule approximately 1 mm thick, extended at two opposite poles into gelatinous threads several centimeters long. It could not be determined whether the threads of the several eggs had initially been connected as the animal moved during oviposition. One thread would appear before the egg and the egg would remain attached to the cloaca by the second thread. The

conditions in the photography cage were too restricted to permit conclusions regarding normal behavior.

The eggs were entirely yellow and apparently infertile. They were rapidly attacked by mites (*Caloglyphus* spec. possibly *C. longitarsus* Banks; ident. by Howard Sengbusch), and even the isolated eggs showed signs of decay within two days.

This represents only the second record of oviposition in the genus. Goeldi (1899, *Ueber die Entwicklung von* Siphonops annulatus. *Zool. Jahrb., Syst., 12:170–73, pl. 9*) presented a detailed description of a female *Siphonops annulatus* (Mikan) found coiled around a clump of six eggs, in a possibly continuous string, from each end of which there was a free, thread-like projection. The eggs contained gilled embryos near term (in December at Therezopolis, R. J., Brasil) and one egg measured 10 by 8.5 mm.

My *S. paulensis* accepted only incapacitated crickets, while a specimen of the possibly sympatric (Dunn, 1942, *The American caecilians. Bull. Mus. Comp. Zool., 91:481*) *S. annulata* fed avidly on large earthworms but refused a variety of arthropods. National Science Foundation Grant NSF G-9054 supports the work for which these specimens were obtained.—CARL GANS, *Department of Biology, The University of Buffalo, Buffalo 14, N. Y.*

A TRAILING DEVICE FOR SMALL ANIMALS DESIGNED FOR FIELD STUDY OF THE GILA MONSTER (*HELODERMA SUSPECTUM*).—To determine normal movement, voluntary activity period, and other ecological information for the Gila monster, a mechanical trailing device was made which traces the movement of the animal with a fine nylon thread. While several mechanical designs have been tried with varying degrees of success, this model (Fig. 1) is believed to fulfill requirements best.

The spool is attachable with no apparent discomfort or annoyance to the animal. It is of sufficient range for one or more twenty-four hour periods and sufficiently compact to follow the animal into subterranean burrows without impeding its progress.

The materials used include quarter-inch polyethylene tubing, a one inch ornamental bulb, a paperboard disk, a cardpaper shield and tail funnel, DuPont NYMO fused nylon thread (weighing one gram per 100 yards), and three-quarter inch plastic tape. Its total weight is about 20 grams; it holds 500 to 800 yards of thread, is 1⅛ inches in outer diameter, and has a total length of three inches.

After assembling to stage four as shown, the spool is taped to the animal in the field (Fig. 1C). The thread is tied to a field marker and the animal is released to proceed on its way.

The following results illustrate the use of the technique. With the exception of those for one animal, the data are for laboratory animals released in areas other than their original home ranges. The primary intent of these particular trial runs was to perfect mechanical aspects of the tailspool.

Nine individuals of *Heloderma suspectum* unspooled a total of 2130 yards of thread. During the first four trials in which early model tailspools were used, two animals ran out of thread and escaped and two broke threads due to spool failure. Of the other five trials using an improved model, all were recovered in good condition.

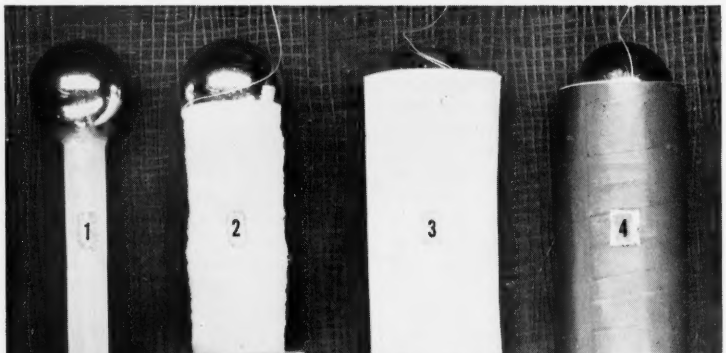
Animals travelled during ten out of a total of 17 days of monitoring. When on the move an average of 235 yards per animals per day was travelled. The daily distance varied from 30 to over 500 yards. The most rapid sustained movement was 350 yards in three hours.

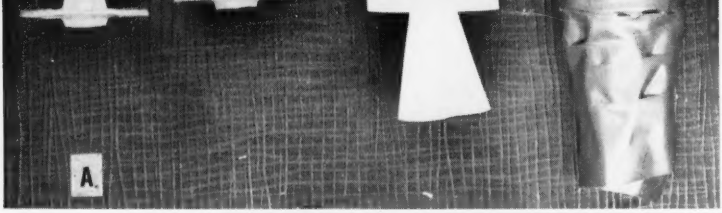
Eleven burrows were entered, three of them two to four times. In a burrow in which entrance had been indicated by a thread, further observation resulted in seeing a new hole opened to the surface. Subsequent thread patterns indicated a preference for this new hole. One animal, on a cool evening, attempted to burrow into an open hillside forty yards from the release site. After two inches of excavation, it continued on fifty more yards, discovered a small hillside burrow under a root of a paloverde, enlarged it by two times, and spent the night in it.

Another animal that was located in the field and supplied with a tailspool on the spot, travelled fifty yards and remained in a burrow until morning.

Thus, this model of the tailspool has entered and departed from eleven burrows of various sizes, traversed over 2000 yards of highly variable desert habitat, and adequately followed seven of the nine trial animals, even when still in the developmental stage. The use for such a device in studies of physiological ecology of small animals is obvious and is the purpose for its construction.

Its development has been stimulated by the interest of Dr. C. H. Lowe, Jr., of the Department of Zoology. The project was carried out in the University of Arizona Arid Lands Program supported by a grant from the Rockefeller Foundation.—WALLACE G. HEATH, *Department of Zoology, University of Arizona, Tucson, Arizona.*





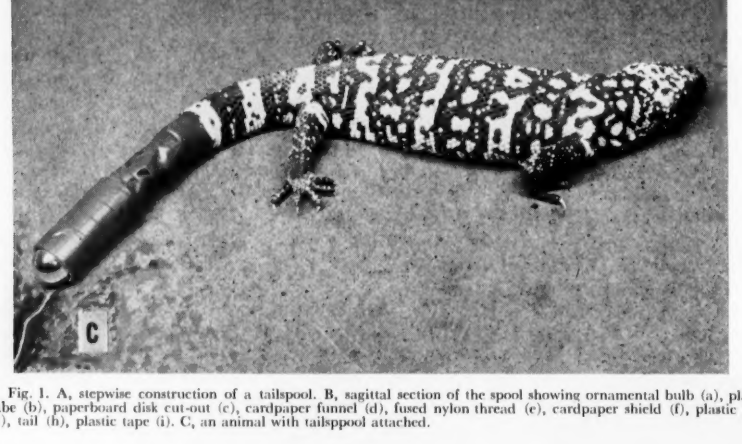


Fig. 1. A, stepwise construction of a tailspool. B, sagittal section of the spool showing ornamental bulb (a), plastic tube (b), paperboard disk cut-out (c), cardpaper funnel (d), fused nylon thread (e), cardpaper shield (f), plastic glue (g), tail (h), plastic tape (i). C, an animal with tailsppool attached.

NOTES ON TEIID LIZARDS IN SOUTHERN BRAZIL.—The family Teiidae is represented by four species in Rio Grande do Sul, the southernmost state in Brazil. The opportunity to collect and observe them was given me during a stay at the Universidade do Rio Grande do Sul in Pôrto Alegre from 1953 to 1955. My visit was made possible by the Campanha Nacional de Aperfeiçoamento de Pessoal de Nivél Superior (Capes) of the Brazilian Ministry of Education with supplementary grants from the Rockefeller Foundation. Thanks are due these organizations, and also Dr. Rodolfo Ruibal for a number of helpful suggestions.

Rio Grande do Sul is similar to southeastern Texas (centering around Columbus County, Texas) in many ways. Both areas are located at the same latitudes (30°) and both are transitional between forests to the east and plains to the west. Their topographies and physiographies are comparable, and their locations in respect to wind and ocean currents are much alike. These similarites have produced strong resemblances in climate, soil, flora, and fauna. Convergent adaptation is apparent in all of the animal groups. In the amphibians and reptiles, approximately 75% of the total number of species of the two regions show some convergence. Details relating to two of the strongest convergents have been discussed elsewhere (Milstead, 1961, *in* Vertebrate Speciation, Univ. Texas Press). Three of the four teiids found in Rio Grande do Sul show convergence with lizards found in southeastern Texas.

Cnemidophorus lacertoides
Duméril and Bibron

This appears to be the rarest teiid in southern Brazil. I found it at only one locality, a large sand flat near Lake Emboába, 10 Km. southeast of Osório. The habitat is like that of *C. sexlineatus* in southeastern Texas. *Cnemidophorus lacertoides* is very similar to *C. sexlineatus* in coloration, size, shape, and behavior.

Large black ants (Formicidae, 2.8 cc. total) were the only items found in the stomachs of four individuals of *Cnemidophorus lacertoides*.

This species was originally described as a member of the genus *Cnemidophorus*, but Burt (1931, *Bull. U.S. Nat. Mus. 154, 286 pp*) and Burt and Burt (1931, *Bull. Amer. Mus. Nat. Hist. 61:227–395*) re-allocated it to the genus *Ameiva*. The latter genus is characterized (1) by the possession of a sheath between the posterior tips of the scaly portion of the tongue and the larynx, (2) by the parallel lateral scale rows on the tail, and (3) by the flat posterior margins of the tail scales. The genus *Cnemidophorus* is characterized (1) by the absence of a sheath between the tongue and larynx, (2) by the overlapping lateral scale rows on the tail, and (3) by the spinose posterior margins of the tail scales. On the basis of these characteristics, *lacertoides* unquestionably belongs in the genus *Cnemidophorus*.

Pantodactylus schreibersi schreibersi
(Weigmann)

This is the smallest of the teiids in southern Brazil. It is not as numerous as *Teius teyou*, but appears to be about as widespread. My records are from in or near forests or from towns. The habitats are virtually identical with those occupied by the ground skink, *Lygosoma laterale*, in southeastern Texas. The little teiid and the ground skink are very similar in coloration, size, and shape. Both genera have developed a window in the lower eyelid composed of a single, large, transparent scale.

Eight stomachs of *Pantodactylus schreibersi* yielded 0.225 cc. of food items: 33.3% terrestrial isopods (3 pillbugs), 52.8% arachnids (1 scorpion, 3 spiders), 2.8% lepidopteran (1 caterpillar), and 11.1% hymenopteran (1 bee). All of the food items were minute representatives of their groups. *Lygosoma laterale* is the only lizard species in southeastern Texas known to take large numbers of pillbugs.

Teius teyou teyou (Daudin)

Teius teyou is the most numerous and widespread of the teiids in southern Brazil. It occurs wherever there are open areas with some rock cover. In this respect and in its external morphology, habits, and behavior, it is similar to *Cnemidophorus sacki gularis* in the United States (see Milstead, 1957a, *Tex. J. Sci., 9:410–47;* and 1957b, *Southwest Nat., 2:105–21*).

Food items in the stomachs of 16 specimens of *Teius* from Pôrto Alegre amounted to 5.9 cc: 0.3% arachnids (1 spider), 38.0% orthopterans (9 grasshoppers), 29.0% isopterans (329 termites), 0.6% homopterans (2 cicadellids), 21.0% coleopterans (5 beetles), 9.0% lepidopterans (4 caterpillars), and 2.1% dipterans (2 flies). The bulk of the food items recorded by Laughlin (1958, unpub. M.A. thesis, Univ. Texas) for *Cnemidophorus sacki gularis* from southern Texas consisted of 38% orthopterans and 32% isopterans. Milstead (1957a, *op. cit.*) recorded 31.2% orthopterans, 15.2% isopterans, 26.1% lepidopterans, and 15.0% coleopterans for *C. s. gularis* from southwestern Texas.

One individual of *Teius teyou* was a female

with three large (20 × 11 mm.) immature ova. Two ova were situated in the lower coelom parallel to the main body axis, and one was transversely arranged between the liver and the tops of the other two ova. The stomach and small intestines were displaced dorsally and anteriorly.

The hole of one individual was found in midsummer 1954 on a hillside under a large stone. A tunnel about a half inch in diameter led downward at an angle of approximately 30°. The tunnel extended about six inches and terminated in a small, horizontal chamber approximately one by one and a half inches. The lizard was situated in a U-shaped position with most of the torso in the chamber and the head and tail in the tunnel. This differs considerably from the horizontal holes described for four species of *Cnemidophorus* (including *sacki*) by Milstead (1957b, *op. cit.*).

Tupinambis teguixin (Linnaeus)

The lagarto or teju, largest of the world's teiids, is one of the most abundant lizards in southern Brazil and the most ubiquitous in habitat selection. Individuals were found in every type of terrestrial habitat available, and on low, ephemeral marsh islands accessible only by swimming. Upon being chased, a few were observed to swim.

The teju is a true omnivore with the widest range of diet recorded for any teiid. Examination of eight stomachs yielded a total food volume of 90.5 cc: 30.0% vegetation (*Vitis* and *Philodendron* fruits), 20.0% gastropods (fragments of 5 large land snails), 30.0% arachnids (1 scorpion, 3 spiders), 8.0% orthopterans (2 grasshoppers, 12 wood cockroaches), 30.0% coleopterans (20 beetles, 3 larvae), 5.4% lepidopterans (2 caterpillars), and 3.4% mammal (hair, teeth, fragments of skull of *Ctenomys*). Shell fragments of the land snails consisted mostly of operculae. This may indicate that the lizards crack the shells to consume only the soft parts. Individuals in nature were observed to feed on various windfall fruits and fish. Concentrations of tejus occur in stands of Banana Imbé (*Philodendron* sp.) when the fruit is ripe (January), and along beaches where commercial fishermen bring in their nets and discard "trash" fish. Captive specimens in the Pôrto Alegre Zoo were observed to feed on mangoes, bananas and fish. The fish were fed to caimans, but were fished out of the caiman pool by the tejus.

Hensel (1868, *Arch. Naturg., 34, pt. 1:323–356*) and von Ihering (1953, Da Vida dos Nossos Animais, 3rd ed., Rotermund Co., São Leopoldo) report that tejus are considered a menace in Brazil because of their raids on hen houses for eggs and chicks. Ditmars, (1938, Reptiles of the World, Macmillan Co., N.Y.) records eggs, chicks, and rats consumed by a captive specimen in the New York Zoo. Von Ihering reports that tejus make a small hole in an egg and suck the contents, but Ditmars states that his captive cracked the shell and lapped the contents.

There is little interspecific food competition among teiid lizards in southern Brazil (Milstead, 1961, *op. cit.*). Because of the size of tejus and their versatility in both habitat selection and diet, however, juvenile individuals may offer some competition to adult *Cnemidophorus* and *Teius*.

One teju opened for stomach analysis contained 32 oviducal eggs that averaged 23 mm. in diameter. In addition, each ovary contained about 50 enlarged follicles of one to three mm. in diameter.

Hatchling tejus are about the size of adult individuals of *Teius teyou*. The ground color of hatchling tejus is reddish-brown. The back is crossed by a series of white bands that are interrupted dorso-laterally by white blotches. With increasing age, the ground color becomes melanistic, the bands and blotches fuse, and the completed bands become less distinct. A young adult has a black trunk with indistinct white bands and a tail brilliantly marked with alternating black and white bands. An old adult retains the trunk coloration of the young adult, but the tail becomes progressively melanistic with age (Ditmars, *op. cit.*, pl. 10). Hatchling tejus do not have the differentiated teeth described for this species.

Three captive tejus were observed at the Pôrto Alegre Zoo for a period of three days in mid-summer (January), 1954. The meager data obtained indicate that tejus spend most of their time sunning, and that their activities are dependent upon air temperature rather than soil temperature, relative humidity, or wind velocity. Tejus emerged from their holes or shelters in the morning and began sunning at an air temperature of about 23°C. Foraging began at an air temperature of from 27° to 30°C. The time from emergence to foraging required about two hours (8:30–10:30 A.M., approximately). The first two hours of foraging time consisted of alternate foraging and sunning. The pen in which the lizards were held was so situated that it became completely shaded by four P.M., and the air temperature in the pen fell below 23° C. Teju activity ceased between three and four P.M. Wild individuals were seen as late as sunset. It would be expected that in nature, where the lizards have a chance to choose sunny areas,

a second period of sunning and foraging and a final period of sunning would precede the complete cessation of activities (Milstead, 1957b, *op. cit.*). The large size of these lizards and their consequent need for extensive sunning explains Ditmar's observation (*op. cit.*) that they have a preference for clearings. This preference is not exhibited during foraging, however.

The three captive tejus tended to band together rather than exhibit social antagonism or division of the pen into home ranges. This behavior may be attributable to the heterogeneous mixture of large reptiles and mammals in the pen. A fourth teju, newly caught, was introduced into the pen on the second day of observation. It was extremely wary of the other tejus over two days of observation, but the presence of the new one was ignored by the others.

When approached in nature these large lizards are shy and usually retreat through the brush with noise befitting their size. If cornered, they respond first by rapidly vibrating the tail as many non-poisonous snakes do. If provoked, they attack with the jaws agape. Von Ihering (*op. cit.*) states that they are frequently encountered by hunting dogs and attack first with the teeth and then with repeated lashes of the tail until the dog retreats or the hunter intervenes with a stick. It might be added that a stick is sometimes handy for defending the hunter.—WILLIAM W. MILSTEAD, *Department of Biology, University of Kansas City, Missouri.*

THE IDENTITY OF THE TADPOLE OF *ANOTHECA CORONATA* (STEJNEGER).—Taylor (1954, *Univ. Kansas Sci. Bull. 36, pt. 1, no. 8:589–95*) has described an egg-eating tadpole from Costa Rica as belonging to the species *Anotheca coronata* (Stejneger). Starrett (1960, *Misc. Publ. Mus. Zool. Univ. Mich. no. 110:1–37*) rejected this assignment on the basis of other material including four individuals just transforming.

On August 25, 1960 I collected four tadpoles from a water-filled tree cavity, about two feet from the ground, at 1050 m. above sea-level on the southern slope of Volcán San Martín in the region of "Los Tuxtlas," southern Veracruz, México. The intestines of these tadpoles contained anuran eggs, visible through the abdominal wall at the time of collection. Comparison of the present material with the descriptions of Taylor and Starrett and with the latter's specimens, through the courtesy of Dr. Charles F. Walker of the Museum of Zoology, University of Michigan, leaves little doubt that Taylor's species is represented. The four new individuals (UMMZ 121945) were kept alive in the field laboratory in order to ascertain their identity. One was preserved when it had attained a total length of 42.5 mm. and had developed small hind limbs. A second was preserved after the left forelimb had emerged, while the remaining two were allowed to undergo complete metamorphosis. The last two specimens have snout-vent lengths of 21.5 and 22.0 mm. To one experienced with *A. coronata* in the field, there can be little doubt that this species is represented. The bony cranial spines, a distinctive feature of adults of this monotypic genus, are absent as has been previously reported in the literature for an immature individual. Distinctive lateral dark spots and leg banding, a ventral pattern, vestigial finger webbing, highly reduced (for hylids) toe webbing, and the presence of a tarsal fold in these specimens distinguish them from other hylid genera of southern Veracruz.

The tadpole agrees in all aspects of external anatomy, other than size, with Taylor's description. Mrs. Starrett's material, although adequately described, remains enigmatical.—DOUGLAS C. ROBINSON, *Department of Wildlife Management, Texas A. and M. College, College Station, Texas.*

PREDATION ON EGGS OF THE SALAMANDER, *AMBYSTOMA MACULATUM*, BY CADDISFLY LARVAE.—Little information concerning predation on amphibian eggs has been recorded. Cory and Manion (1953, *Copeia: 66*) reported predation on *Rana sylvatica* eggs by leeches, *Macrobdella decora*, which did not eat either *Ambystoma tigrinum* or *A. maculatum* eggs. J. R. Harrison (1961, pers. comm.) has observed the destruction of *Rana pipiens* eggs by leeches.

On February 22, 1961, I found several freshly laid egg masses of *A. maculatum* being devoured by larvae of the caddisfly *Ptilostomis sp.* (Phryganeidae) in a small semi-permanent pond in Orange County, North Carolina.

When discovered, the *Ptilostomis* larvae, which have strong chewing mouthparts and strong, clawed, recurved legs, had burrowed through the thick outer jelly coat of the *Ambystoma* egg masses and were eating the eggs inside. The cases, which the larvae hold onto by their hooked anal legs, did not penetrate the egg mass, but protruded from the surface. Several cases on one egg mass made the latter resemble a pin cushion bearing coarse pins.

It did not appear that the larvae had eaten the jelly to gain access to the eggs, but the jelly coats of several egg masses, with dimensions of up to 2½ x 3 x 4½ inches, were completely riddled. It could not be determined whether a

larva penetrated the egg mass more than once. Several clumps of eggs supported up to 6 larvae and up to ⅔ of the eggs had been eaten when the observations were made. Five out of 15 egg masses found the same day were being fed on by *Ptilostomis* larvae.

On subsequent visits to the pond on February 24 and March 9, similar situations were observed. Turbid water prevented further observations and photography. Several egg masses with feeding larvae were brought to the laboratory, but the larvae were sensitive and refused to perform their tricks for the camera. The feeding behavior probably depends on proper light conditions as well as suitable temperature and oxygen levels.

Both predator and prey are found in this pond each year, but the *Ambystoma maculatum* population does not seem to be a large one. Although this is the first time predation has been observed, it is likely that *Ptilostomis* is the first of a series of predators (including a number of other insects, both larval and adult), which limits the population of *Ambystoma maculatum* in this particular pond.

This work was supported in part by the National Science Foundation.—TED D. MURPHY, *Department of Zoology, Duke University, Durham, North Carolina.*

A CORRECTION CONCERNING THE PHALANGEAL FORMULA OF THE TURTLE, *STYLEMYS NEBRASCENSIS* LEIDY.—Since its original description (Leidy, 1851, *Smith. Contr. Knowledge 6:101–12*), the relationships of the genus *Stylemys* have been variously regarded. Misconceptions have seemed to plague the type species (*nebrascensis*) from Leidy's original belief that the plastral buttresses were separate bones, to the presumed emydine phalangeal formula described by Case (1936 *Contr. Mus. Paleont., Univ. Mich. 5:69–73*).

After the discovery of his error concerning the plastral buttresses Leidy (1873 *U.S. Geol. Surv. Terr. 1:358*) vacillated between the use of *Testudo* (*Geochelone*) and *Stylemys* when referring to the species *nebrascensis*. This would suggest that he must have recognized a very close relationship between the two genera. Cope (1884 *U.S. Geol. Surv. Terr. 3:770–81*) recognized the validity of *Stylemys*, but placed it in the Emydidae without specific comment. On the other hand, Hay (1908, *Fossil Turtles North Amer.*, Washington) was of the opinion that *Stylemys* belonged in the Testudinidae. This was based on the general similarity of various skeletal elements to those found in more typical members of this group. However, these comparisons were made on the basis of relatively few elements definitely referrable to *Stylemys*. Completely articulated skeletons would have been necessary to validate some of Hay's conclusions.

Such an individual was available to Case when he described a specimen of *Stylemys nebrascensis* (University of Michigan Museum of Paleontology 17600) which, besides being represented by a complete shell, possessed the bones of the feet, limbs, girdles, and the neck and tail. Most important is that the bones of the feet were in their normal position. His interpretation of the feet of this specimen led him to suggest that *Stylemys* should be regarded as an emydid with terrestrial adaptations. This suggestion was based on the presumed presence of three phalanges on each digit. All known unquestioned testudinine species possess two phalanges on each digit.

Though subsequent workers have accepted Case's interpretation concerning the number of phalanges in *Stylemys*, they have continued to regard the genus as testudinine, though with an emydine type foot (Williams, 1950, *Amer. Mus. Nat. Hist. Bull. 95:7–36*; 1952, *Amer. Mus. Nat. Hist. Bull. 99:544–60*; Loveridge and Williams, 1957, *Bull. Mus. Comp. Zool. 115:160–557*).

This interpretation has served to introduce new elements of doubt concerning the distinctness of the (now subfamilially recognized) Testudininae. Case's observation seemed to dispose of the one tortoise character, the phalangeal formula, that seemed most surely diagnostic. Furthermore, it indicated that *Stylemys* was not particularly closely related to the remaining tortoises, though certain other characters seemed to suggest some affinity to *Gopherus*.

In a study of the variation within several species of North American fossil tortoises placed in the genus *Stylemys*, several important features of the available samples became obvious. Some of these affect our present concept of the characteristics of the genus. These include the following: (1) Several characters presumed to be generically diagnostic for *Stylemys* are probably specific characters of *S. nebrascensis*. (2) At least some of the presumed generic characters show considerable individual variation. (3) Some of the presumed generic characters are ontogenetically variable to a considerable degree. (4) Several observations made of *S. nebrascensis* in the past, and thought to be indicative of generic distinctness, are now known to be in error.

Together these general conclusions suggest that the entire problem of the "Stylemys-type" tortoise should be re-examined to determine the validity of this concept. However, it is only with the phalangeal formula in *Stylemys nebrascensis* that this note is concerned.

A re-examination of the feet of the University of Michigan specimen of *Stylemys nebrascen-*

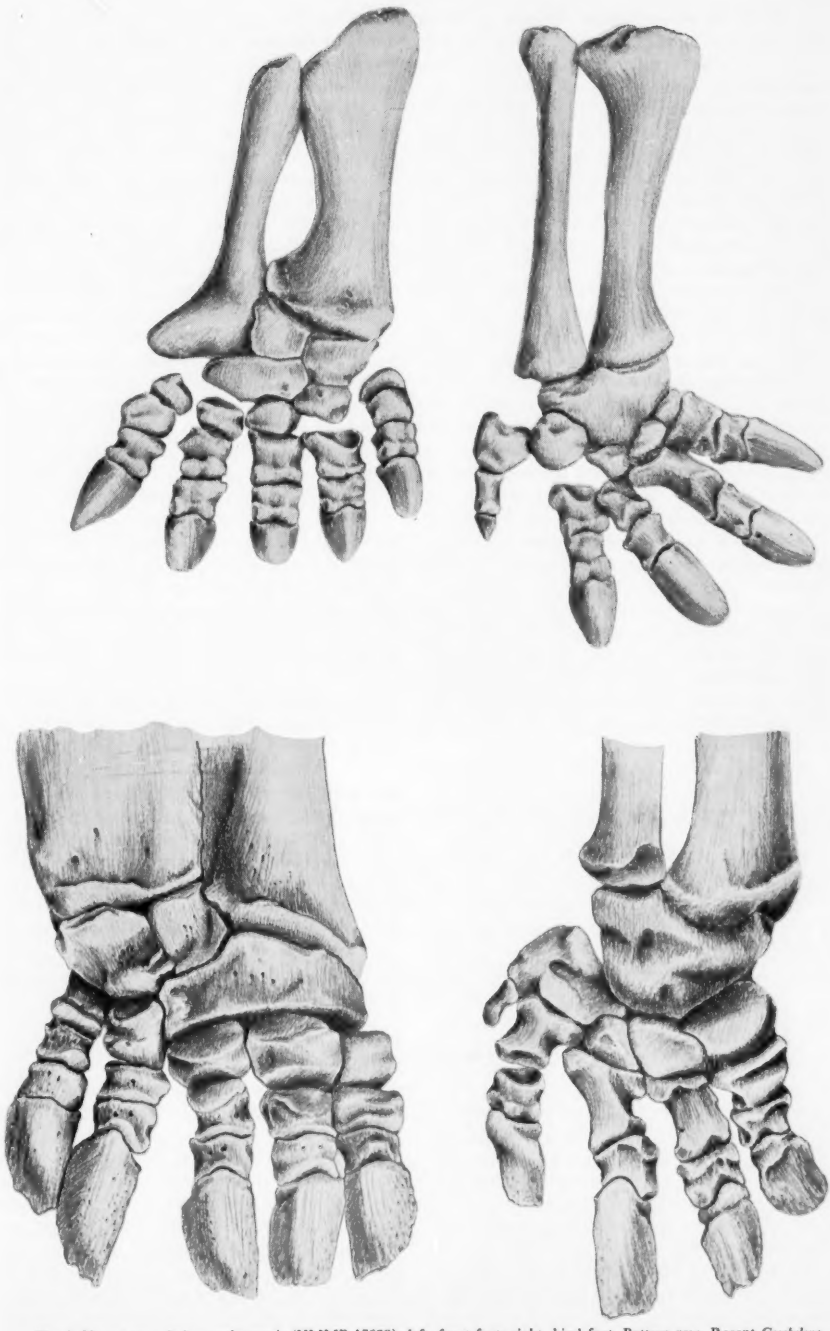


Fig. 1. Upper row, *Stylemys nebrascensis* (UMMP 17600); left, front foot; right, hind foot. Bottom row, Recent *Geochelone sulcata*; left, front foot; right, hind foot.

sis has shown that Case's statements regarding the number of phalanges in this individual is in error. The phalangeal formula of this specimen is identical to that found in all other testudine turtles. That is, there are only two phalanges in every digit, not three. This is indicated in Case's own illustrations (Plate II, figs. 1–4). The feet of this important specimen are here redrawn, with those of a Recent *Geochelone sulcata*. A comparison of these feet will show the similarity in number and disposition of the component elements (fig. 1).

Case's erroneous observation was apparently based on some confusion regarding the presence of metacarpals and metatarsals. Though the number of elements in these series may be reduced through loss or fusion, they are always represented in some fashion or another in all turtles. In his description of the foot of the Michigan specimen Case draws attention to all of the foot elements (by describing their position or size), except the metatarsals and metacarpals. Though there is some carpal and tarsal fusion in this specimen (common in many turtles), it possesses a normal complement of elements proximal to the phalanges.

This correction strengthens our concept of the naturalness of the subfamily Testudininae; and weakens (to some extent) the distinctness of the genus *Stylemys*. The remaining generic characters of *Stylemys* will be reviewed when the analysis of the described species of *Stylemys* is completed.

Prepared under the partial sponsorship of NSF Grant No. 017613.—WALTER AUFFENBERG, *University of Colorado, Boulder, Colorado.*

A MASS UNIDIRECTIONAL MOVEMENT OF *NATRIX SIPEDON PICTIVENTRIS*.—On the night of June 1, 1961 we noticed large numbers of *Natrix sipedon pictiventris* moving south southwest across the Wacahoota Road in Alachua County, Florida. Systematic observations on the following two nights confirmed that a mass unidirectional movement was in progress.

The Wacahoota Road is six miles long and connects Highway 331 with Highway 441. Through part of its extent the Wacahoota Road separates two extensive marshes known as Payne's Prairie, and Levy Lake. The greatest movement of snakes took place between the marshes. Additional roads bordering the area were driven to confirm the unidirectional movement of snakes crossing the Wacahoota Road. Specimens ranged from juvenile to adult size.

On June 2 the first *N. s. pictiventris* was observed crossing the road at about 7:45 PM, heading in a south southwest direction from Payne's Prairie toward Levy Lake. At 8:00 PM we began to drive the road at a speed of about 15 miles per hour. Between 8:00 and 8:27 PM, 53 *N. s. pictiventris* were counted headed south southwest across the road. Snakes struck by cars were not counted after the first drive. In a second drive between 8:27 and 8:45 PM, 29 individuals of this species were counted, all headed in the same direction. In a third drive between 8:45 and 9:05 PM, 15 specimens were counted and, in a fourth drive between 9:05 and 9:30 PM, seven specimens were counted, all moving in the above direction. In the fifth and final drive between 9:45 and 10:15 PM, two specimens were recorded going south southwest, but one was going in the opposite direction. Because of the rapidity of movement of these snakes, we do not believe that any specimens were counted twice. In summary, 107 out of 108 *N. s. pictiventris* were observed moving in the same direction, from Payne's Prairie toward Levy Lake, between the hours of 7:45 and 10:15 PM, June 2, 1961.

On the night of June 3, further observations were made. Between 8:17 and 8:44 PM, 11 out of 12 *N. s. pictiventris* were recorded headed south southwest, and between 8:44 and 9:10 PM, ten snakes of this species were seen headed in that direction. The intensity of the mass movement had evidently decreased. In summary, 21 out of 22 *N. s. pictiventris* were observed moving in the same direction, from Payne's Prairie toward Levy Lake, between the hours of 8:17 and 9:10 PM, June 3, 1961.

On two occasions on the night of June 2, specimens disturbed by cars passing near them moved back toward Payne's Prairie, but eventually turned again and continued toward Levy Lake. Two other snakes were caught, and then irritated by shaking them by the tail. When they were placed back on the road pavement they hesitated momentarily, then crawled across the road toward Levy Lake. One snake was struck by a passing car, but crawled, with part of its viscera trailing behind, toward Levy Lake.

The reason for the unidirectional movement appears to be associated with a condition of general drought in the Gainesville, Florida area. A communication from Dale Birkenholz of the Department of Biology of the University of Florida informs us that Payne's Prairie was nearly dry on June 16, and further states "This grass zone (a *Panicum* zone) dried up, and this was the majority of water snake habitat. So thousands of acres of *Natrix* habitat dried up, probably between the middle of May, but primarily between the last of May and the first to the middle of June. Just when the critical time occurred, I do not know." Levy Lake still offered

good water snake habitat on June 16. Birkenholz states "I visited it (Levy Lake) where it comes close to the Wacahoota Road, and water is very evident. It has not dried up like most of Payne's Prairie".

F. Wayne King of the Department of Biology of the University of Florida, and the senior author noticed a unidirectional movement in *Seminatrix pygea* at Payne's Prairie in the summer of 1957, although, this was not during a period of drought, but during a rainstorm.

A project of marking *Natrix sipedon* in the Payne's Prairie-Levy Lake area might eventually establish whether the unidirectional movement of June 1, 2, and 3, 1961 was an emigration, immigration, or migration. Moreover, the means by which the animals orient toward suitable habitat remain to be discovered.—J. ALAN HOLMAN, *Department of Biology, Illinois State University, Normal, Illinois* AND WILLIAM HOLMES HILL, *Department of Biology, Howard College, Birmingham, Alabama.*

METAMORPHOSIS OF *PSEUDOTRITON PALLEUCUS* WITH IODINE.—Through the kindness of Dr. Edward McCrady and the immediate assistance of Dr. Harry Yeatman and Prof. Fritz Whitesell, I was able to collect a series of the neotenic salamander *Pseudotriton palleucus* from Sinking Cove Cave, Franklin County, Tennessee, less than a month after appearance of the description of the species by McCrady (1954, *Copeia: 200–206*). Two large individuals were placed in a quart jar provided with screen top, and the jar was then immersed in ice water in a portable ice box. Some two weeks later the salamanders were transferred to a battery jar of water at 48° F in a refrigerator at the University of Tulsa.

A few drops of concentrated iodine-potassium iodide solution were added every four or five days. In approximately three months one salamander had completely metamorphosed but the other seemed unaffected by the treatment or by subsequent treatment carried on for an additional three months.

The metamorphosed salamander was placed in a terrarium at room temperature and lived a little over six months until mid-summer when the temperature went above 100° F. After death it was cleared in KOH and the skeleton stained with alizarin red. There is a single premaxilla (verified by dissection). The nasal spines of the premaxilla enclose a large fontanelle; the spines are not fused posterior to the fontanelle. The nasal bones are widely separated. The prefrontals do not border the nares.

I use the generic allocation *Pseudotriton* rather than *Gyrinophilus* in agreement with Grobman (1959, *Copeia: 60–63*).—ALBERT P. BLAIR, *Department of Life Sciences, University of Tulsa, Tulsa, Oklahoma.*

REVIEWS AND COMMENTS

GUIDE TO MARINE FISHES. By Alfred Perlmutter. N. Y. University Press. 431 pp. Numerous text figs. $6.50.—The appearance of this new guide to Atlantic Coast marine fishes is a most welcome event. The only comparable work, Breder's Field Book of Marine Fishes of the Atlantic Coast, was first published in 1929 and has been long in need of a thorough revision. Perlmutter's book now provides the only up-to-date source for the identification of the fishes of a large section of the Atlantic coast of the United States.

Following a brief introduction, which ends with the definition of eight technical terms, and a short section which tells how to use the key, the body of the book is divided into two sections: the key occupies 216 pages; a general information section of 188 pages includes outline classifications of Chondrichthyes and Osteichthyes and, for each species, gives brief data on color, distribution, size, economic importance, and often on food, reproductive habits, behavior, etc. Separate indices to common and scientific names terminate the book.

Fishes found in the area between Cape Cod and Cape Hatteras are included. While coverage is a matter of author's prerogative, I wish the geographic limits could have been extended. The supply of Fishes of the Gulf of Maine (Bigelow and Schroeder, *U. S. Fish and Wildl. Fish. Bull. 74, 1953*) is nearing exhaustion, and it would be good to have some sort of substitute. The fishes of this particular region are well-enough known that no insurmountable problems should arise from their inclusion. On the other hand, only an audacious worker would attempt at the pres-

ent time a compilation for the area south of Cape Hatteras. This area is now the scene of such intense activity and rapid accumulation of new information that any book would be out-of-date before publication. Still I would like to see it done.

The key uses a highly touted system of "silhouette" identification, which as it turns out, is nothing more than the use of line drawings with pectoral fins, eyes, and other lateral structures included and occasionally indicated by arrows. The illustrations accompanying the key are outlines in white against a gray background. Perhaps by intent, the lines are not sharp, and such structures as eyes and jaws, which should be clear, are not. The illustrations in the general information section, which are gray on white, are much more appealing than those in the key, though hardly sharper. The key itself is long, and therefore cumbersome. Perlmutter states his intention to avoid the problems inherent in trying to produce keys to orders and families based on external characters, but in so doing a monster has arisen. The lack of stopping points is bound to discourage the casual user. If one is willing to key out certain orders or families in more than a single place in the key, there is no great difficulty involved, and by so doing, it is possible to split a key into small parts, which is desirable. Furthermore, this forces the reader into at least a passing acquaintance with higher categories (however ephemeral or multinomial), again a desirable result. The pity of it is that, by and large, Perlmutter's key essentially does all this, without taking the trouble of saying so, or taking advantage of it. Finally, the key follows the precedent, annoying to any scientifically-oriented user, of using no scientific names. In spite of all efforts, common names remain a multifarious thorn in the side, and should be accompanied by a scientific name in any key.

Regarding the included species, I fail to see why some are left out and others included. For example, *Salmo salar* and *S. gairdnerii* are included, while *Salmo trutta* and *Salvelinus fontinalis*, both of which have sea-run forms, are not! None of the Lepisosteidae, Cyprinidae, Catostomidae, Ictaluridae, Esocidae, Percidae, or Centrarchidae that are known to enter salt or brackish waters are included. A number of species noted in not-too-recent papers are missing; examples: *Polynemus octonemus*, *Thunnus obesus*, *Mycteroperca microlepis*, *Acanthocybium solandri*, *Eucinostomus californiensis*, *E. gula*, *Stellifer lanceolatus*, *Umbrina coroides*, *Tetrapturus belone*, *Coryphaena equiselis*, *Nomeus gronovii*, *Cubiceps nigriargenteus*, *Seriola rivoliana* (= *falcata*), *S. fasciata*.

I am especially puzzled at the selection of deeper-water forms. When *Merluccius albidus* and a number of deep-water sharks are included, why not other species that trawlers commonly take with them such as *Urophycis chesteri*, *Citharichthys spilopterus*, *Sebastes marinus*, *Helicolenus dactylopterus*, *Peristedion miniatum*, and *Lepophidium cervinum*. If only for the sake of pedantry, the hagfish, *Myxine glutinosa* and the chimaera, *Hydrolagus affinis* should have been included.

To the prying nomenclaturist, there are some incorrect scientific names and family names that should have been corrected, and a few species are misplaced. These few discrepancies mar the otherwise modern tenor of the work. *Conger oceanicus* is in the family Congridae, not Anguillidae. *Fundulus ocellaris* should be changed to *F. confluentis*, *Tylosurus marinus* to *Strongylura marina*, *Parexocoetus mesogaster* to *P. brachypterus*, *Gadus callarias* to *G. morhua*, *Balistes carolinensis* to *B. capriscus*. Sea horses are not placed in a separate family from the pipefishes. The family Moronidae for striped bass and white perch is not currently recognized, and *Morone americana* should be *Roccus americanus*. A separate family, Otolithidae, for the sea trouts is not currently recognized, nor is Hemitripteridae for the sea raven. The flying gurnard is now considered as *Dactylopterus*, not *Cephalacanthus*, and its family changes accordingly. *Histrio picta* should be *Histrio histrio*.

The material that is covered in the key and in the general section is generally accurate and interesting. There are a few places where the key does not work out, but this is almost impossible to avoid. The differences between the flying fishes *Cypselurus heterurus* and *C. furcatus* are based on adults in the former, juveniles in the latter. There is really no known satisfactory difference between the adults of the species. The dorsal and anal fins of yellowfin tuna, *Thunnus albacares*, used as the only identification character, are long only in large adults; smaller specimens with these fins shorter are easily confused with *T. atlanticus* or *T. obesus*.

All the criticisms so far are more or less forgivable; one more is not. Seldom have I seen a book which wastes space in such a flagrant manner. I am not pleased by the illustrations, but they are repeated time and time again in the keys, and again in the general information section. To take an example at random, in keying out a halfbeak (*Hyporhamphus unifasciatus*), we find its outline on pages 59, 61, 107, and 310. The cunner (*Tautogolabrus adspersus*) is illustrated on pages 9, 179, 180, and 393. Even this would be acceptable if other efforts were made

to save space. But in illustrating a single general character, often half a dozen or more examples are portrayed, each repeated at further steps in the key. For instance, on page 67, six examples are shown of "caudal fin continuous with dorsal and anal fins", in addition to four others at the same place which illustrate virtually the same thing. On page 83, to illustrate "small bony shields on caudal peduncle", not only is a perfectly clear drawing of the tail of a jack given, but five species are shown in addition, contributing nothing to further clarification of the concept and occupying all but a small corner of the page. Compounding the felony, the illustrations in the key are all on the odd-numbered pages, the text of the key on the even-numbered pages. Thus in the text, there are numerous large blank spaces, on at least 19 pages occupying half or more of the page. The illustrations could have been placed after the proper rubric in the text and saved many pages.

It is unfortunate that technicalities mar this book, for its usefulness and even necessity are beyond question. The key appears to be well-constructed, and the general information section is quite worth while; and these are, after all, the really important considerations. I have little doubt that Atlantic coast fishermen, ichthyologists, and beachcombers will be using the book for some time to come.—ROBERT H. GIBBS, JR., *Department of Biology, Boston University.*

LIVING AMPHIBIANS OF THE WORLD. By Doris M. Cochran. Doubleday and Co., Inc., 1961, 199 pp., 220 photos (77 in color). Cloth $12.00. This volume, the seventh in *The World of Nature Series,* completes the coverage of cold-blooded vertebrates. As in the volumes on reptiles (*Living Reptiles of the World* by Schmidt and Inger) and fishes (*Living Fishes of the World* by Herald), this book presents a conspectus of the living families of the class covered but, unlike the two other volumes, includes special sections on "biological aspects" and on the keeping of animals as pets.

The text covers each family of amphibians without over-emphasizing any particular taxonomic group or geographic area. Omissions are bound to occur in any popular book because of the limitations of space and a reviewer should perhaps not quibble with the unhappy choices that are forced on author and publisher. However, the failure to mention the important tropical American genera and species of Plethodontidae (perhaps one-fourth or more of the living species of salamanders) is inexplicable.

Approaches to the many problems involved in popularization of natural history are as numerous as authors and publishers. One of these problems concerns documentation. James Oliver, in *North American Amphibians and Reptiles,* tried to credit each bit of information to the researcher responsible for it. Dr. Cochran has followed the practice of omitting source references, a practice that can be justified on the assumption that the book is not written for professional herpetologists. Dr. Cochran, however, has provided a selected bibliography should a general reader want to go deeper into the literature on amphibians.

Regardless of one's preferences in such matters, every author of a popular book should explain specialized terminology, should be factually accurate, and should attempt to explain observations and relationships in terms of generally accepted biological theory. Unfortunately Dr. Cochran's text does not observe these rules in many instances. Terms such as "spermatophore" (p. 18), "neoteny" (p. 19), "anuran" (p. 47), and "alveolar glands" (p. 187) are not likely to be understood by a layman without reference to other sources and yet these terms as well as others are introduced without definition.

Reference to an oviduct reaching over the back of breeding female *Pipa pipa* (p. 50), to posteriorly convex centra in Opisthocoela (p. 47), to *Notaden bennetti* as a little, 1½ inch long frog (pp. 93–94), to arboreal habits of *Rana hosii* (pp. 157–158), to virtually year-long "hiding" of *Ambystoma maculatum* except when breeding (p. 22), and to springtime breeding in *Rana goliath* (p. 159) are examples of factual errors.

Generalizations to the effect that male frogs croak as often in amplexus as before (p. 180), that "nearly every other wild creature around them" is a potential predator on frogs (p. 185), and that amphibians do not feed during the breeding season (p. 187) do not jibe with my observations.

Claims that the Pipidae live "practically as scavengers" (p. 49), that the digital disks of hylids have "suction power" (p. 112), that *Leurognathus marmoratus* is "exceedingly rare in collections" (p. 34), and that the absence of a pelvic girdle is indication of the primitive structure of caecilians (p. 15) are misleading or incorrect.

Teleology is difficult to avoid. But such statements as "[*Ranodon*] lives in mountain brooks and consequently has much diminished lungs" (p. 19) not only run contrary to current biological theory, but also fail to give the layman any notion of the complexity of biological thought.

The dust jacket asserts that this volume pre-

sents "...the most beautiful and informative pictures of amphibians ever assembled." The analogous blurb for the volume on fishes merely refers to "300 superb photographs..." No comment was made on the quality of illustrations in the reptile volume, which was the first of these three books. Whether this progression marks a growing confidence of the publisher in the principal marketing appeal of the series or a gradual improvement in the quality of the photographs is not for me to decide. As co-author of the reptile volume, I can attest, however sadly, that the remarkable illustrations are the chief selling point for at least the reptile volume and I suspect for the fish and amphibian volumes as well. More often than not a person commenting on the reptile book will say, "It's beautiful," which though not exactly what an author of a factual account wants to hear, may be the kindest remark possible.

Actually, superlatives are appropriate, for the photographs are beautiful, and Dr. Cochran and the publisher should be proud of having assembled them. The taxonomic and geographic representations are broad. It is especially pleasing to have good photographs of living caecilians and so few distracting, artificial backgrounds. The suspicion that three photographs are of posed, dead animals (pp. 29, 32, and 41), the misidentification of a salamander (p. 41 does not show a *Eurycea lucifuga*), and an incorrect statement of range in one legend (pl. 35) mar the illustrations, but only to the extent of keeping them from being perfect.

Despite the numerous, minor errors in this volume, the text has one outstanding feature that charmed me and will probably please all of Dr. Cochran's friends: the style of writing is distinctively hers and it requires no trick of imagination to hear her voice as one reads. To the many herpetologists whom Dr. Cochran has helped over the years this feature of the book will alone justify its purchase.—ROBERT F. INGER, *Chicago Natural History Museum, Chicago, Illinois.*

SYSTEMATIC DIVISION AND EVOLUTION OF THE COLUBRID SNAKE GENUS *NATRIX*, WITH COMMENTS ON THE SUBFAMILY NATRICINAE, (Proc. Acad. Nat. Sci. Philadelphia, *112* (3), sep. 23, 1960: 41–71.) by Edmond V. Malnate. The science of taxonomy has two primary purposes: first, to discover the degrees of relationship between organisms; and second, to form an hierarchical classification consistent with these degrees of relationship, unambiguous in its names, for filing of observations and indicating the degrees of generality of statements. And there are two ways of circumventing the primary purposes of taxonomy by obscuring the degrees of relationships and making the filing system less efficient. One way, popular among Nineteenth Century ornithologists and mammalogists, is to place each certainly distinguishable species in its own genus without indicating degrees of relationship between these monotypic genera. The other method, steadily gaining in popularity and a point of great pride among many modern taxonomists, is to place all species that might possibly be related in one omnibus genus, without indicating the degrees of relationship between these monotypic genera. Theorists in taxonomy whose primary interests have been ornithology and mammalogy have drawn much attention to the villainy inherent in splitting, but have said little about the dereliction of the taxonomist's duty implicit in a very large genus. As a result, almost any paper proposing to lump genera is accepted and cheered, but any proposed splitting of a genus meets with hostile suspicion and the assumption that the author must wear spats and a celluloid collar.

The history of herpetology is quite different from that of ornithology, for it has never had a period of excessive splitting comparable to bird systematics. Instead, there has been a desire to keep generic definitions simple and to draw generic characters from a sort of "list of respectable generic characters". In the case of snakes, this list has expanded through the years from head-scutes to include the dentition, vertebral hypapophyses, obvious cranial features, and the hemipenial structure.

It has fallen to herpetologists of the twentieth century to split some hodge-podge genera left to us by Boulenger, Günther, and even Cope. Before Malnate's division, the genus *Natrix* contained nearly ninety species. Malnate divides "*Natrix*" into five genera: *Macropophis* Boulenger 1893, *Fowlea* Theobald 1868, *Rhabdophis* Fitzinger 1843, *Natrix* Laurenti 1768, and *Amphiesma* Dumeril and Bibron 1854. The largest of these, *Amphiesma*, contains 39 species. My feelings are that with all its shortcomings, Malnate's classification of *Natrix* is much the best that has been presented.

But Malnate's paper should serve to accelerate research in *Natrix*, not deflect attention from the genus. If "*Natrix*" was allowed to stand in obvious chaos for over half a century, what is to happen now that Malnate has partially made order? It is the duty of a reviewer to point out where work remains to be done or where corrections are in order.

First, because the most easily dismissed, may be taken minor matters of the classics and spell-

ing of names. Thus, in the name "*hypomelas*" the "s" is not an adjectival ending and even in a feminine genus the specific name remains "*hypomelas*", not "*hypomela*". The name "*sarasinorum*" is not the neuter of an adjective "*sarasinus*", but is the genetive plural of the Latinized name Sarasin; the snake was named after the Sarasin brothers and Malnate's emendation to "*sarasinora*" is invalid.

Editors and readers we may call consumer-readers adore brevity and succinctness. But there is another body of readers we may call producer-readers; they are the people who read Malnate's paper propped up in front of the binocular microscope and use the paper as a tool in their own attempts to make sense of "*Natrix*". Obviously, Malnate has gone to considerable trouble to gather data on all but a few of the species of "*Natrix*". When he makes the statement (p. 42), "Apical scale pits, at least among Asiatic forms, are a specific, subspecific, and even an individual variant and have not proved to be useful here," he puts each producer-reader to the task of re-doing all Malnate's examinations of the scale-pits, for it is possible that while Malnate has not succeeded in fitting scale-pits into the evolutionary scheme, someone else might find the elusive explanation for the presence or absence of pits. Such a brilliant and creative intelligence might rebel at duplicating several years of research so that one paper could be four pages shorter. Similarly, anyone who has been able to examine the hemipenes of rare or almost unprocurable Asiatic snakes owes it to workers less blessed to give a detailed description of each species examined. Take such a sentence as (p. 42): "One to three strongly enlarged spines at the base of the organ may be present (or absent); when present they may or may not be followed distad by a small cluster of spines noticeably stouter than those elsewhere on the organ." Malnate obviously has data on basal spines that would have prevented Cope from separating the Natricinae and Lycodontinae on this basis. If Malnate had given us the details he would have saved us the trouble of pursuing fruitless searches that he had abandoned, probably after considerable time and with considerable disappointment.

Malnate makes his primary split on the basis of hemipenial structure. In *Rhabdophis*, *Fowlea*, and, according to Malnate, *Macropophis*, the sulcus spermaticus is forked, whereas in *Amphiesma* and *Natrix* the sulcus is simple. Unfortunately, Malnate designated *Tropidonotus hypomelas* of New Britain as the type of *Macropophis* but had not seen that species and framed his diagnosis on the Malaysian *maculata* and the Philippine *barbouri* and *dendrophiops*. But *hypomelas* (A.M.N.H. No. 82318) has a hemipenis very much like that of New Guinea "*Amphiesma*", except that there are no enlarged basal spines; the sulcus is almost simple and extends to a smooth pocket in the crotch of a bilobate organ (each of the lobes receiving a separate insertion of the long retractor); the sulcus does extend a short distance onto either lobe but fades out far short of the tip of the lobe (Malnate's T-shaped sulcus). The name *Macropophis* is thus not available for the genus Malnate intends, but becomes a synonym of "*Amphiesma*", for "*Macropophis*" *hypomelas* appears to be closely related to the watersnakes of New Guinea. The species is confined to New Britain, but is sometimes referred to the New Guinea fauna through confusion with an undescribed species in New Guinea with similarly high number of maxillary teeth, slender and *Dendrelaphis*-like body with very long tail, and a similar black stripe on the side of the throat. This species differs from *hypomelas* in having basal hemipenial spines, 15 (rather than 17) scale-rows, and much lower ventral and subcaudal counts. It appears to link *hypomelas* with the *picturatus-mairi* group.

Thus, in spite of his hemipenial diagnosis, Malnate's working concept of *Macropophis* is: those species of Boulenger's *Tropidonotus* with slender body and long tail and many maxillary teeth. The genus is an unnatural one and its apparent (p. 47) "relictual, peripheral distribution in the Indo-Australian Archipelago" is better interpreted as parallel specialization on isolated islands with limited faunal invasions, a possibility considered by Malnate on p. 53 but finally discarded at the top of p. 54.

Just what should be done with *barbouri*, *dendrophiops*, and *maculatus*, the types of Malnate's concept but not of his name, is a problem. They certainly are not *Natrix* or "*Amphiesma*" and the gradual enlargement of the posterior maxillary teeth combined with absence of a nuchal gland make them unlike any *Rhabdophis*, although affinity with that genus is strongly suggested by the combination of lateral nostrils, a forked sulcus spermaticus with each branch of the sulcus extending far onto a branch of the organ and presence of scale-pits. In *maculatus* the posterior maxillary teeth are rather abruptly enlarged, and *Rhabdophis chrysarga*, without nuchal gland, is not too different. The *chrysarga* group may be the key to the phylogeny of many Old World "*Natrix*".

Malnate's genus *Fowlea*, for watersnakes combining forked sulcus, dorsally directed nostrils, fewer than 30 maxillary teeth, maxillary teeth

gradually enlarged posteriorly, and absence of scale pits, is certainly a natural group distinct from other "*Natrix*". But Malnate gives no characters for separating *Fowlea* Theobald 1868 from *Xenochrophis* Günther 1864; nor can I find any such characters. It is always tempting to lump a genus of three species with a monotypic genus, and here the evidence of affinity justifies yielding to temptation.

In the past *Rhabdophis* has been used for watersnakes with abruptly enlarged posterior maxillary teeth and has included both the snakes related to *subminiata* (the type) and also the species related to *stolata*. Malnate removes the *stolata* group from *Rhabdophis* and is certainly justified. But I doubt that the forms without a nuchal gland (e.g. *chrysarga*) should be included in the same genus with those possessing the gland. The genus *Macropisthodon*, as urged by Malnate (pp. 55, 61–62), is very closely related to the species of *Rhabdophis* with a vertebral (nuchal) gland, but distinguished by lengthening of the posterior maxillary teeth. My personal tastes in this matter are to synonymize *Macropisthodon* with *Rhabdophis;* Malnate never quite brings himself to do so, although he does sink *Balanophis*, characterized by grooved posterior maxillary teeth. The dental variation within *Rhabdophis* reported by Malnate makes it seem inconsistent to recognize *Macropisthodon* while synonymizing *Balanophis* and *Rhabdophis*. But this is a matter of taste and Malnate's position is defensible.

Malnate's two remaining genera, *Natrix* and *Amphiesma*, differ from the preceding genera in having a simple sulcus spermaticus. Malnate says that the organ may be either simple or bilobate, but I have always found the organ bilobate; this probably reflects a difference between my own and Malnate's concept of "bilobate", for Malnate says of "*Amphiesma*" *doriae*, *mairi*, and *picturata* that the organ is "single with an undivided sulcus" (p. 58). My own dissections of these species show that the sulcus is simple, extending to the crotch of an organ that is divided for from one to three subcaudal-widths, with the tip of each of these lobes attached to a separate slip of the long retractor. Other *Natrix* and *Amphiesma* appear to be similar. Probably no two people are in precise agreement on the meaning of "bilobate".

Few can question the validity of Malnate's separation of "*Natrix*" with a simple sulcus from "*Natrix*" with a forked sulcus, but a note of caution should be sounded, lest too great an importance be attributed to the nature of the sulcus in *Natrix* because of the great usefulness of the sulcus in distinguishing major groups of colubrid snakes.

The simple sulcus spermaticus of *Natrix* and *Amphiesma* is fundamentally different from the simple sulcus of "colubrines". In "colubrines" the everted organ is usually more or less bilobate and the sulcus extends onto one, but not the other, of the two lobes. But in *Natrix* and *Amphiesma* the sulcus extends to the crotch of the lobes to end in a smooth area between the lobes and does not extend onto either lobe (Dowling and Savage, *Zoologica, 45(1), 1960:17–28*, have well illustrated this difference). The "colubrine" hemipenis is asymmetrical, both in itself and in relation to that of the opposite side, for whether it is the right or left organ, the "right" lobe bears the sulcus; thus, whichever organ is used, sperm will be discharged opposite the opening of the same oviduct. (Without precise knowledge of the orientation of the hemipenis in copulation, it cannot now be said whether it is the right or left oviduct of female colubrines that receives the sulcus tip of the hemipenis, and it is impossible now to say what connection this asymmetry of the hemipenis has with the frequent asymmetry of the ovaries.)

But the *Natrix* hemipenis is symmetrical with its fellow, and, aside from basal spines, symmetrical within itself. The tip of the sulcus lies on the midline of the female cloaca. The *Natrix* hemipenis can be derived from the hemipenis of such a form as *Rhabdophis chrysarga*, where the two branches of the sulcus each extend only half way along the respective lobes of the organ. Dr. H. Dowling has pointed out to me a peculiar feature of the *Rhabdophis* hemipenis: the branches of the sulcus lie on the sides of the lobes facing the crotch (a condition that might be called centripetal), whereas in most snakes with a forked sulcus, the branches of the sulcus lies on the sides of the lobes facing away from the midline of the organ (a condition that might be called centrifugal). A centrifugal sulcus presumably deposits sperm on the lateral wall of the cloaca of the female, and shortening the branches of the centripetal sulcus (thus concentrating the point of sperm discharge) would lead to the *Natrix* hemipenis. The lining of the cloaca of the female is variously papillose, plicate, and flounced, and quite possibly furrows in the ornamentation of the female cloaca come to replace the sulcus spermaticus in conduction of sperm.

I am not convinced that the division of the "*Natrix*" with simple sulcus into *Natrix* and *Amphiesma* is a natural one. Either "*Am-*

phiesma" and *Natrix sensu* Malnate should each be further split or the two combined. My own guess is that the former course will prove more satisfactory, for there is a distinct possibility that several lines of *Rhabdophis* without nuchal gland has developed a simple sulcus. The superficial similarity between some *Rhabdophis chrysarga* and some *"Amphiesma" doriae* is suggestively close, and from *"Amphiesma" doriae* there is a transition to the remainder of the New Guinea-Australian group of *"Amphiesma"* through an unnamed New Guinea form with the characteristic color-pattern of *doriae* combined with the 15 (rather than 17) scale rows of *picturata, multiscutellata, montana,* and *mairi.* On pp. 59–60 Malnate expresses some perplexity at the failure of *Rhabdophis* to enter New Guinea and the failure of *"Amphiesma"* to attain the Lesser Sundas. A possible explanation worth considering is that *Rhabdophis* has, in fact, entered New Guinea, but in the process has shortened the branches of the sulcus spermaticus and thus become *"Amphiesma".*

A hedge against the possibility of polyphyletic origin of *Amphiesma* and *Natrix* would be to redefine *Rhabdophis* to include only those species showing the peculiar specialization of a nuchal (vertebral) gland and to include the glandless forms such as *chrysarga,* along with *Amphiesma,* in *Natrix.* But this only begs the question of the true relationships of the species.

It is puzzling that Malnate recognized *"Amphiesma"* as distinct from *Natrix* on a trivial and not always clear-cut character in the position of the nostril, yet leaves the North American *"Natrix",* which are genuinely viviparous with a placenta (See Conaway and Fleming, *Copeia, 1960:53–55*), in the same genus with the oviparous Old World forms. The amount of evolution indicated by the development of a placenta seems much greater than that indicated by the lateral rotation or upward rotation of the nostrils; particularly so when we note that the type of *Natrix, N. natrix,* has *Amphiesma*-like habits and nostrils, whereas the type of *"Amphiesma", N. stolata,* has *Natrix*-like habits and nostrils.

Perhaps Malnate was influenced by the existence of a poorly known, perhaps intermediate, form, *Natrix annularis* from China and Formosa. *Natrix annularis* is a live-bearer, but it is not known whether it has a placenta. Whether it is but an Old World development parallel to New World *Natrix* or a real East Asiatic representative of a New World group remains to be discovered. But I cannot avoid the suspicion that Malnate was prevented from separating New World and Old World Natrix by the hobgoblin of herpetology, the "respectable generic character". For some reason it is not considered proper in herpetology at present to use the presence of a placenta as a diagnostic feature of a genus. Nevertheless, it is a point of some interest that all the New World natricines that have been studied in this regard are placental. To my mind there is better evidence of close affinity between New World *"Natrix"* and *Thamnophis* and *Storeria* than there is of affinity between New World *"Natrix"* and Old World *Natrix* (perhaps excepting *N. annularis*).

Malnate concludes with some remarks on the subfamily Natricinae. He defends the value of the character "hypapophyses developed throughout the vertebral column", even though noting various reports of snakes with posterior hypapophyses that are clearly members of genera supposedly without posterior hypapophyses. Malnate discusses the matter of posterior hypapophyses more as to its value as a clew to relationships than as to its utility as an identifying feature of genera. Custodians of large and growing collections from all over the world are faced with a very real problem of quick and accurate identification, and the discovery that a character requiring some dissection and preparation is not infallible probably will lead them to disagree with Malnate and regard determination of the presence or absence of posterior hypapophyses as not worth the bother.

But here I must agree with Malnate. Some of the disrepute into which the character "hypapophyses developed throughout the vertebral column" has fallen is the result of lumping a considerable variety of ventral vertebral apophyses under the single name hypapophyses. The hypapophysis of the posterior thoracic vertebra of *Natrix* is a process arising from the rear half of the ventral surface of the centrum and extending back to hook under the ventral lip of the cotyle of the centrum just posterior. I do not know of any snake with hypophyses fitting this description that does not appear to be related to *Natrix* on other grounds. On the other hand, it is by no means certain that the converse is true, that all snakes related to *Natrix* retain the hypapophyses. The African snakes related to *Lycophidion* and *Mehelya* have posterior hypapophyses and are perhaps distantly related to *Natrix,* although the hypapophyses do not precisely fit the above description. The burrowing African snakes of the *Miodon-Polemon-Aparallactus* series seem closely related to *Lycophidion,* agreeing with that genus in the exclusion of frontal bone from the orbital margin by prefrontal-postorbital contact and in the backward

extension of the nasal gland over the dorsolateral surface of the prefrontal bone; but the hypapophyses are absent posteriorly. Again, the burrowing viperid *Atractaspis* shows great reduction of the posterior hypapophyses, even though exceptionally long posterior hypapophyses are characteristic of most Viperidae. This leads to the suspicion that some snakes, particularly burrowers, without posterior hypapophyses may actually be related to *Natrix*.

If Malnate has failed at providing a perfect classification of *Natrix*, it is because he has made a laudable attempt to do two generations' work in one. In his discussion of the evolution and characteristics of his genera, Malnate sketches the outlines of smaller groups within his genera. I hope that Malnate will present a firmer rendering of these outlines in the future, for I believe that these are really the most useful parts of his paper. The stage of synthesis, when small natural groups are fused into larger genera, may be a generation away, and it is impossible to predict now what course this synthesis will take. Already there are hints that the closest relatives of some of the groups of the old "*Natrix*" are genera that have been recognized for a century as distinct from *Natrix* (see, for example, the above discussion of *Xenochrophis* and of *Macropisthodon*). By attempting to steer a middle course between splitting and lumping, Malnate may have put off discovery of some unsuspected affinities that will be the basis of generic classification fifty years from now.

But we may all be grateful to Malnate for making the beginnings of a phyletic, rather than merely formal, arrangement of the watersnakes.—SAMUEL B. MCDOWELL, JR., *Rutgers, the State University, Newark, New Jersey*

SNAKE MAN, THE STORY OF C. P. J. IONIDES. By Alan Wykes. Simon and Schuster, 1961: 269 pp., 14 photographs, 2 tables. $4.50.—Alan Wykes, noted English writer of fiction, has written a lively biography of a rebellious individualist who delighted in flaunting his disdain for convention and high authority and in using language that does not pass the censor. No doubt snakes appealed to him partly because they are so widely disliked. From early youth Ionides had an interest in natural history and succeeded in putting this interest to varied uses. A flexible conscience allowed him to be game warden and poacher at the same time, and a deep respect for animals did not interfere with a willingness to kill them for scientific and commercial purposes.

An Englishman in spite of a Greek name, he knows enough about amphibians and reptiles to collect them intelligently. Arthur Loveridge reported on two collections made by Ionides, and the book under review includes lists of nine rare reptiles and 22 rare mammals secured by this intrepid naturalist. The finding and shooting of these mammals entailed arduous labor. This hunting figures heavily in the book, and exciting accounts of the pursuit and capture of venomous snakes, especially mambas, are also told at length. However, the herpetologist will be more impressed by the observations on the habits of water cobras, mambas, and other snakes. Circumstances surrounding the bites, some of which were experimental, inflicted on Ionides by species of *Causus*, *Bitis*, and *Atractaspis* are included. It is well to point out that the physical disabilities from which he suffered when visited by Alan Wykes were not the results of these bites.—CLIFFORD H. POPE, Winnetka, Illinois.

LOS REPTILES DE CHIAPAS. By Miguel Alvarez del Toro. Instituto Zoologico del Estado, Tuxtla Gutiérrez, Chiapas, Mexico, 1960, pp. 7–204, Illus. $2.00, obtainable from the Instituto Zoologico del Estado, Aptdo. Nro. 6, Tuxtla Gutiérrez, Chiapas, Mexico.—With its narrow Pacific coastal plain extending to the southernmost tip of Mexico, with barrancas dissecting high central highlands, a subhumid corridor on the Atlantic side of the Continental Divide, and humid lowlands bordering Tabasco to the north, the state of Chiapas offers ample diversification in habitats to support a rich reptile fauna. It is of considerable interest, therefore, to have information concerning the habits, habitats, and life histories of many of the species provided by a competent and talented naturalist living in the area.

Alvarez del Toro, an enthusiastic naturalist and a careful observer, overlooks few opportunities to broaden his knowledge of vertebrates as director of the zoological garden in Tuxtla Gutiérrez. Inevitably he has learned considerably more about the reptiles than the usual collector whose forays into the area are commonly devoted to tossing as many specimens as possible into preservative. Alvarez del Toro has observed reptiles in their normal habitats as well as in the zoo. What he learned about them is presented in lucid Spanish, perhaps intended primarily for educated Mexican naturalists, laymen and students. Nevertheless, so much of the information concerning food habits, life histories, and behavior is original and hitherto unrecorded that the book represents a notable contribution to our knowledge of reptiles in the American tropics.

Quite properly in a book addressed to the layman, Alvarez del Toro provides general informa-

tion and corrects many egregious beliefs of the sort people nearly everywhere entertain. Of greater interest to herpetologists, however, are such accounts as that of *Iguana iguana*. In addition to notes on its diet and predators, Alvarez del Toro describes the fighting associated with the male's maintenance of territorial rights, his pursuit of the female and the wounds he sometimes inflicts on her while engaged in the activities that precede copulation.

In Chiapas this large iguanid mates between October and December, but the female does not prepare for oviposition until March or April. Having selected a site, she starts excavating a burrow, visiting it daily to dig it a bit deeper. On the day of oviposition, however, she starts earlier and works more frantically to reach a depth of one to two meters before she deposits as may as sixty eggs, usually in the afternoon. She arranges the eggs in layers, each separated by loose earth mixed with rubbish, which is also used to fill the burrow. After scraping a bit more earth and debris over the opening, the female returns to her feeding site in some tree nearby, but she comes back daily to add a bit more earth and rubbish to the nesting site during the first two weeks of the three months required to incubate the eggs.

This brief summary of a much more detailed account exemplifies the sort of information Alvarez del Toro supplies. He can not, of course, provide lengthy accounts for each of nearly a hundred species that he describes, but he can tell you that *Leptotyphlops phenops* often lives in termite nests, feeding on termite larvae, and that it lays eight to twelve eggs in June or July. He reports that *stenorrhina* is called a culebra alacranera because it has no hesitancy in devouring scorpions though it also eats insects and spiders. Little has been published concerning *Xenosaurus*, but now we know that its activities are largely crepuscular, and that it gives birth to its young, delivering only three over a period of four to seven days.

An appendix lists 14 turtles, 3 crocodilians, 52 species (plus 8 subspecies) of lizards representing 8 families, and 71 species (with 10 additional subspecies) of snakes for Chiapas. As Alvarez del Toro notes, further exploration will doubtless reveal additional species within the state. A few names on the list, such as *Loxocemus sumichrasti*, have been assigned to synonymies, and in some instances the names employed do not conform to present usage. *Oxybelis acuminatus* is employed for the *bejuco*, for example, though *O. aeneus* has now been in use for the snake since 1945. But such minor matters scarcely detract from the general usefulness of the work.

The systematic status of several species inhabiting the Isthmus of Tehuantepec remains to be ascertained. For some groups there probably is insufficient material in preserved collections to determine relationships satisfactorily. Nevertheless, the observations of naturalists, such as Alvarez del Toro, who live in the area often provide important data that supplement what the systematist can glean from studying preserved material. The status of *Pseudemys grayi* is a case in point. The name can scarcely be based upon the male of *P. ornata*, as Carr (1938, Herpetologica 1:131) once suggested, for Alvarez del Toro informs me that he has seen both sexes of the two species, whose separate distributions overlap. Moreover, the hatchlings of the two are readily identified by their distinctive patterns.

With such notable exceptions as Felix Kopstein, whose studies in Java contributed so much to our knowledge of the life histories of reptiles in the tropics, few naturalists living in such areas have devoted much effort to studying the habits, behavior, or breeding cycles of reptiles. Techniques, such as those employed by Henry S. Fitch in his investigations of movements, growth, and breeding cycles of amphibians and reptiles in the United States, remain to be used in long-term studies in tropical regions. Much can be done by naturalists with the intimate knowledge Alvarez del Toro displays to pave the way for more intensive scientific investigations. Such books as *Los Reptiles de Chiapas* serve, moreover, to enlist the support and understanding of the inhabitants of tropical regions.

It should be encouraging to those interested in the fauna of Mexico to see such worth while books being published in the country. Alvarez del Toro, whose efforts to educate the public merit his recognition as an outstanding Mexican naturalist, writes with the authority of the careful observer. There may be occasional errors in his interpretations, but few of us succeed in avoiding all pitfalls. Alvarez del Toro deserves full credit for this extremely useful and thoroughly readable summary of his knowledge of Chiapan reptiles.—C. M. Bogert, *American Museum of Natural History, New York, N. Y.*

CHECK LIST OF THE AMPHIBIANS AND REPTILES OF CANADA AND ALASKA. By E. B. S. Logier and G. C. Toner. Life Sciences Division—Contribution 53, The Royal Ontario Museum, Toronto, Canada, 1961: 92 pp. $3.50.—This is a revised edition of a check list first issued in 1955, and incorporates many new records that have accumulated since then. The new edition is printed in a good clear type and is attractively bound.

The treatment of each species starts with the scientific name and author, then the common name, followed by a statement of the range of the form in Canada. After this there is a listing of specific localities where specimens have been taken. Each of these is accompanied by a museum citation where the specimens may be found or if based on a literature record, the paper is cited. Where the species is widespread and common, not all localities are cited, but important and peripheral localities are listed. With other species, all of the known localities are listed. Accompanying each species is a map with the specific localities indicated by dots. The usefulness of this book is further enhanced by the ten pages of bibliography.

There are relatively few typographical errors in this book and three of these occur in the table of contents, where *Aneides, catesbeiana* and *septentrionalis* are all misspelled. On map 50 *Trionyx* is misspelled. There are also a few inconsistencies in scientific names, such as *Thamnophis butleri* on the map but *Thamnophis radix butleri* in the text and table of contents. Some of the changes in names since the last North American Check List (Schmidt 1953) are incorporated, as, for example, *Ambystoma laterale*. Other changes equally valid are omitted, thus *Pseudacris nigrita septentrionalis* is used for *Pseudacris triseriata maculata* and *Emys* for *Emydoidea*.

These errors and inconsistencies are trivial and in no way impair the usefulness of this worthwhile reference.

This reviewer also feels that one full page map of Canada with the provinces and principal geographic features named, would greatly facilitate use of this book for those of us "south of the border."

The usefulness of such a list to zoogeographers is obvious but of even greater value are the many questions raised by a study of the ranges of Canadian reptiles and amphibians. Since Canada extends well into the Arctic, it is to be expected that poikilothermous animals will reach their northern limit of distribution in Canada. Yet a comparison of the range of *Rana sylvatica* with that of other amphibians indicates that there must be factors other than sheer cold and shortness of summer operating. A similar situation is apparent in the reptiles with *Thamnophis sirtalis* extending much farther north than other reptiles. One wonders what manner of adaptation is possible to permit these two forms to succeed in an environment so generally unsuited to cold blooded animals. These and many similar questions are apparent in the detailed distribution maps in this book.—NEIL D. RICHMOND, *Carnegie Museum, Pittsburgh, Pa.*

STUDIES ON THE EGGS, LARVAE AND JUVENILES OF JAPANESE FISHES. SERIES I. By Keitaro Uchida, Sadahiko Imai, Satoshi Mito, Shiro Fujita, Masaaki Ueno, Yōichi Shōjima, Tetsushi Senta, Masaharu Tahuku, and Yosie Dôtu. Second Laboratory of Fisheries Biology, Fisheries Department, Faculty of Agriculture, Kyushu University, Fukuoka, Japan. 1958: 89 p., 86 plates. (in Japanese).—This has been the era of publication of a large number of short papers describing the development of single species by fish workers in Japan. Hence, the above coordinated and concentrated work is a refreshing pleasure, as well as being a very useful reference to students of fish life history stages. It contains brief descriptions and illustrations of 83 kinds of fishes from Japanese waters (identified to species for most, subspecies or only to genus for a few). The majority of this work represents original research—many of the developmental stages have never been published before. All of the species are illustrated with line drawings or photographs, some by 20 to 23 different figures. There are a total of 558 illustrations. The figures are very adequate despite the lack of attention to detail in most of the drawings and the poor quality of some of the photographs. Descriptions are brief and concise, but regrettably they follow the "static approach" —in describing the developmental series stage by stage, rather than the dynamic process of describing the major ontogenetic changes as they occur. For some species significant life history notes are included, and several keys to various groups are given. The most notable are keys to larval and juvenile stages of Exocoetidae by Imai. The accounts and illustrations will be useful to workers identifying the young specimens of marine species from other parts of the world, for although the species may differ elsewhere, the generic and familial characters will remain somewhat constant for the groups depicted.

This is the first of a proposed series in this field by Prof. Uchida and his co-workers. It would certainly be advantageous to have it continue. This work has been translated by Shigeichi Hayashi at the Laboratory at La Jolla; and when arrangements can be made, it will be reprinted in English, hopefully with the original figures.—FREDERICK H. BERRY, *U. S. Fish and Wildlife Service, Bureau of Commercial Fisheries, Biological Laboratory, La Jolla, California.*

ON THE ZOOLOGICAL RECORD.—I have received some comments from Alice G. C. Grand-

ison concerning the reviews of the Amphibia and Reptilia sections of the Zoological Record (*Copeia, 1960:163–164* and *1961:250–251*). One point of which I was unaware is that there are two groups involved in the production of a section: the searchers, responsible for assembling pertinent papers, and the recorders or compilers, who classify the references unearthed by their colleagues. Accordingly, gaps and misses in coverage of the literature should not be blamed upon the compilers. Lags in coverage are due in part to the tardy arrival of publications at the British Museum. Reprints help cut down potential lags as well as provide articles in convenient form for the compilers' processing, which may have to include translation and summarization before sensible indexing is possible.

With apologies to the compilers, J. C. Battersby and W. E. Swinton, I wish to take this opportunity to correct an editorial error in the Reptilia section review. The second sentence should have read "... the present section is likewise quite useful..." instead of "... the present section is quite likely useful...".—GEORGE B. RABB, *Chicago Zoological Park, Brookfield, Illinois.*

SUMMARY OF 1961 MEETING

The forty-first annual meeting of the Society was held at the University of Texas, Austin, from March 30 to April 3, in conjunction with the Texas Herpetological Society. The chairman of the Local Committee, W. FRANK BLAIR, was ably assisted by representatives of the University, the Texas Herpetological Society, and nearby institutions.

BOARD OF GOVERNORS MEETING, MARCH 30, 1961

The Board meeting was called to order by President GEORGE A. MOORE at 8:10 P. M., with 37 governors and several guests present. The minutes of the 1960 meetings were approved as published in *Copeia, 1960, No. 4, pp. 395–404*. The Resolutions Committee, appointed by President MOORE, included E. PETER VOLPE, Chairman, JOHN C. BRIGGS, WADE FOX, and KIRK STRAWN. The Stoye Prize Committee included: WILLIAM CLAY, Chairman, GEORGE B. RABB, CARL D. RIGGS, and RICHARD G. ZWEIFEL. The 1962 meeting in Washington, D. C. will be held from June 14 to June 17 (emended dates) with DANIEL M. COHEN as local chairman. The 1963 meetings in Vancouver will be held September 3 to September 7 (emended dates), with the University of British Columbia as host institution and JOHN C. BRIGGS as local chairman (C. C. LINDSEY has replaced BRIGGS, who is moving to the University of Texas). An invitation from JOSEPH R. BAILEY to hold the 1964 meetings at the Duke Marine Laboratory, Beaufort, North Carolina, was accepted, but no dates were set. The annual gift of seventy-five pounds to the Zoological Record was renewed. The Managing Editor stated that the shortage of herpetological papers continues and requested contributions. The editors have begun to plan the 1963 volume to aid in proper observance of the Society's Golden Jubilee. Each past president and honorary foreign member has been invited to submit papers. The Ichthyological Editor, ROMEO MANSUETI has resigned, effective after issue No. 4 of 1962.

Publications Secretary N. Bayard Green reported a net income of $1516.31 from the sale of back numbers of COPEIA, check lists, and other publications. Several out-of-print numbers of the old series have been reprinted, including Nos. 18, 19, 21, 22, 24, 25, 28, 43, 48, 54, 80, 86, 88, 99, 102, and 103.

Checking Account		
Balance on Hand, January 1, 1960		$6,301.97
Total Receipts	$13,077.22	
Total Expenditures	11,435.31	
Balance on Hand, December 31, 1960		7,943.88
Endowment Fund		
Balance on Hand, January 1, 1960		10,239.04
Balance on Hand, December 31, 1960		11,411.26
Revolving Research Fund		
Balance on Hand, January 1, 1960		565.25
Balance on Hand, December 31, 1960		565.25

Financial Report For Calendar Year 1960

JAMES E. BÖHLKE, *Treasurer*

CHECKING ACCOUNT

Balance on hand, Central-Penn National Bank, Philadelphia, January 1, 1960	$ 6301.97

RECEIPTS

Memberships	7742.61
Subscriptions	3309.50
Sale of Publications by Publications Secretary	1488.09
Sale of Back Publications by Secretary	12.00
Sale of the Herpetological Check List	4.50
Sale of the Herpetological Common Names Check List	2.00
Interest from Government Bonds	252.50
Stock Dividends—Mass. Investor's Trust	42.16
Capital Gains distribution—Mass. Investor's Trust	1.56
Sale of Copeia Mailing List	25.00
Donation—Miscellaneous	2.00
Central-Penn National Bank—credit memos	24.39
Refund from the Local Committee for the Chicago meetings	163.00
Mail Permit Refund	3.91
Overpayment of dues	4.00
Subtotal (receipts)	13,077.22
Total	19,379.19

EXPENDITURES AND DISBURSEMENTS

Publication of Copeia		
1959, no. 4	$2555.88	
1960, no. 1	2000.86	
1960, no. 2	2146.61	
1960, no. 3	2227.03	
		8930.38
Secretarial Assistance—Chicago		10.00
Secretarial Services—Philadelphia		200.00
Typewriter rental—Chicago		2.50
Transfer of files—Secretary		7.30
Printing		526.33
Refunds of dues paid in excess		16.00
Postage		
Secretary		74.07
Editor		10.19
Phone calls and telegrams		
Secretary		14.38
Editor		11.61
Petty Cash—Secretary		100.00
Petty Cash—Treasurer-Elect		200.00
Notorial fee		.50
Bank Charges		2.92
Dues, A. I. B. S.		903.00
Donation to Zoological Record		
1959 (late)		140.00
1960		211.13
Stoye Prizes (as announced in Copeia: 1960, p. 403)		75.00
Total Expenditures		11,435.31
Balance on hand, December 31, 1960		
Central-Penn National Bank, Philadelphia		972.53
Security First National Bank of Los Angeles, University Branch		6971.35
Total		19,379.19

ENDOWMENT FUND

Balance on hand, January 1, 1960	
Second Federal Savings and Loan, Philadelphia	$10,239.04
Received from Life Members	750.00
Interest	422.22
Total	11,411.26
Balance on hand, December 31, 1960	
Second Federal Savings and Loan, Philadelphia	10,911.26
Security First National Bank, Los Angeles	500.00
Total	11,411.26

REVOLVING RESEARCH FUND

(A part of the general checking account)

Balance on hand, January 1, 1960	
Central-Penn National Bank, Philadelphia	565.25
Balance on hand, December 31, 1960	
Central-Penn National Bank, Philadelphia	565.25

Mimeographed copies of the entire financial report are available from the Secretary upon request.

The Auditing Committee, composed of FRANKLIN C. DAIBER, Chairman, and CHARLES E. MOHR reported the Treasurer's books to be in "excellent condition," and the report was accepted.

The Secretary reported that as of February 18, 1961, the Society's active list included 623 regular members, 191 student members, 40 foreign members, 118 life members (including 97 paid in full), 292 institutional subscriptions in the U. S., and 153 foreign institutional subscriptions. In addition, 38 free copies of COPEIA are distributed. The list totals 1455 names as compared with 1587 at the time of the last annual meeting (June, 1960). There were 264 members and 76 subscribers delinquent at the time of preparation of this report. Membership applications included with the 1961 annual dues notice resulted in 13 new regular members and 22 student members for a total of $236.00 at a cost to the Society of approximately $25.00.

From June 1, 1960 to February 18, 1961 we received 85 new members and 30 new subscriptions. Nine members have withdrawn, 5 institutions cancelled, and 4 members died; a net gain of 97 names since the last Secretary's report. Thanks to financial aid from San Fernando Valley State College and to the Secretarial Assistance Grant allotted by the Board of Governors in Chicago, the Secretary has not lost an undue amount of his research time.

The reports of the ASIH Divisions were accepted. The Western Division announced that the Student Prize in Ichthyology went to CHARLES R. HITZ, University of Washington; no other awards were made.

The report of the Translations Committee, VLADIMIR WALTERS, Chairman, was tabled. The Committee on Traffic in Venomous Snakes, H.

G. DOWLING, Chairman, reported in detail on an act passed by Congress which became law on September 2, 1960. The important parts of this Act (Public Law 86–702, Section 42, A1) in regard to fishes and reptiles are as follows: "The importation into the United States, any territory of the United States, the District of Columbia, Commonwealth of Puerto Rico, or any possession of the United States, or any shipment between the continental United States, the District of Columbia, Hawaii, the Commonwealth of Puerto Rico, or any possession of the United States, of the Mongoose of the species *Herpestes auropunctatus*; of the species of so-called "Flying Foxes" or Fruit Bats of the genus *Pteropus*; and such other species of wild mammals, wild birds, fish (including mollusks and crustacea), amphibians, reptiles, or the offspring or eggs of any of the foregoing which the Secretary of the Interior may prescribed by regulation to be injurious to human beings, to the interest of agriculture, horticulture, forestry, or to wild life or the wild life resources of the United States, is hereby prohibited." Section A3 states: "Notwithstanding the foregoing, the Secretary of the Interior, when he finds that there has been a proper showing of responsibility and continued protection of the public interest and health, shall permit the importation for zoological, educational, medical, and scientific purposes of any mammals, birds, fish (including mollusks and crustacea), amphibia, and reptiles, or the offspring or eggs thereof where such importation would be prohibited otherwise by or pursuant to this Act, and this Act shall not restrict importations by Federal agencies for their own use." In order to implement this act, government officials have drawn up proposed regulations. These include prohibitions against importation of the following: (13.5) "Any species of fish or their eggs of the Subfamilies *Vandellinae* and *Tridentinae* of the Family Pygidiidae (including the "candiru"); the genus *Serrasalmus* (Piranhas); and genus *Potamotrygon* (freshwater stingrays)." These prohibitions were based on a telephone conversation with Leonard P. Schultz. Under reptiles (13.6) all venomous snakes of the Families *Crotalidae*, *Hydrophiidae*, *Elapidae*, and *Viperidae* were prohibited. In addition to these prohibitions, a specific number of ports of entry were indicated—8 for fishes and 11 for reptiles. It was also suggested (13.10) that a permit would be required for each shipment of these prohibited animals, that the application for the permit must give the number and species of animal to be imported, the purpose, the port of entry, the approximate date of arrival, and other information. It would further require that the imported animals would require an additional permit to be transferred to any other institution. At a meeting to discuss these regulations, the chairman of this committee as well as Roger Conant and Robert Snedigar were ASIH members present. The committee was given to understand that the regulations could be modified for selected institutions. The target date for effecting the regulations was July 1, 1961.

GEORGE RABB suggested that the committee be revised to have a broader scope, and that an ichthyologist be included (EARL S. HERALD later accepted appointment). The committee should be re-titled the Committee on Traffic in Cold-Blooded Vertebrates, and part of their charge should be to provide information on Congressional action. This was passed, as was a motion to accept the report.

The reports of the Committee on Zoological Nomenclature and the Special Committee for the 50th Anniversary were accepted.

The Committee of the Herpetological Check List, WILLIAM RIEMER, Chairman, received permission from the Board of Governors to proceed with the plans for the check list, and was authorized to submit a proposal to the National Science Foundation for financing the check list on a three-year basis. The committee's report was accepted, as was the report of the Committee on Common Names of Fishes, which reported the availability of the 1960 Edition of "A List of Common and Scientific Names of Fishes from the United States and Canada," Special Publication No. 2, American Fisheries Society, 1960. It may be purchased for $1.00 each (paper cover) or $2.00 (cloth cover). Orders, accompanied by remittance payable to the American Fisheries Society, should be addressed to E. A. SEAMAN, *Secretary-Treasurer, American Fisheries Society, Box 483, McLean, Virginia.*

The Constitutional Revision Committee made several suggestions to the Board. A motion to return to a two-year term for the President was defeated, as was a motion to reduce the number of Governors on the Board. Two constitutional amendments were passed unanimously making the following changes necessary:

ARTICLE IV, SECTION 7. Amended to read: The Executive Committee shall consist of the President, President-Elect, Vice-Presidents, Secretary, Treasurer, and Managing Editor.

BYLAWS, ARTICLE 13. Committees. Such committees as he shall deem necessary shall be appointed by the President at any time or by the presiding officer at the annual meeting, unless the composition and function of committees be

otherwise set forth in the Constitution and By-laws or in motions passed by the Board of Governors or by the membership at large at the annual meeting. Unless otherwise specified, committees shall serve from one annual meeting until the next.

The report of the committee was accepted.

The Governors elected for the Class of 1966 include: FREDERICK H. BERRY, DAVID K. CALDWELL, BRUCE B. COLLETTE, ALFRED W. EBELING, and C. CHARLES LINDSEY for the ichthyologists; and RALPH W. AXTELL, MAX HENSLEY, WILLIAM W. MILSTEAD, FINDLAY E. RUSSELL, and DONALD W. TINKLE for the herpetologists. M. J. FOUQUETTE filled a vacancy in the Class of 1964, and WILLIAM E. DUELLMAN does the same for 1965. (One Governor elected at the meeting was found to be a non-member.)

The Board authorized the expenditure of up to $1000 by the Secretary and Treasurer for assistance, and also authorized the purchase of a Society typewriter.

The Board unanimously elected DR. JOHN R. DYMOND, of Ontario, the first Distinguished Fellow of the Society.

A request from the American Society of Zoologists for cooperation of our Society in several ways thought to be advantageous to zoologists was referred to the Executive Committee for action.

The President was directed to write letters expressing the Society's appreciation for services rendered to our fields by J. C. BATTERSBY and E. TREWAVAS upon the occasion of their retirements from the British Museum.

The Editor was requested to secure copyright privileges for *Copeia* (see *Copeia, 1961, No. 2, Cover 2*).

A proposal concerning abstracts and services was brought up by ROMEO MANSUETI. No action was taken by the Governors on suggestions that each article be accompanied by a heading abstract, that all abstracts be translated into Russian, that page proofs be sent to the abstracting services, and that certain changes be made in the copy layout of the journal.

The meeting adjourned at 11:30 P. M.

BUSINESS MEETING

The annual business meeting of the American Society of Ichthyologists and Herpetologists convened at 2:15 P. M., April 2, with GEORGE A. MOORE presiding. The minutes of the 1960 Business Meeting, as published in *Copeia, 1960, No. 4, pp. 395–404*, were accepted. The Secretary reported on the business transacted at the meeting of the Board of Governors on March 30. Brief reports by the Secretary and Treasurer, presenting material in addition to that presented to the Governors, were accepted. The report of the Auditing Committee, which had not been available for presentation at the Governor's meeting, was read and accepted. The two constitutional amendments, given in detail above, were passed unanimously.

The Nominations Committee presented the following slate of officers:

President-Elect: WILLIAM A. GOSLINE

Vice President for Conservation: ROBERT W. HARRINGTON

Vice President for Finance: JAMES E. BÖHLKE

Vice President for Membership: CHARLES F. WALKER

Secretary: JAMES A. PETERS

Treasurer: JAY M. SAVAGE

Publications Secretary: N. BAYARD GREEN

Managing Editor: DAVID L. JAMESON

Ichthyological Editor: ROMEO MANSUETI

Herpetological Editor: ROBERT F. INGER

Ichthyological Editorial Board: LESTER R. ARONSON, ROLF L. BOLIN, HOWARD E. EVANS, ROBERT W. HARRINGTON, ERNEST A. LACHNER.

Herpetological Editorial Board: WADE FOX, JAMES E. MOSIMANN, CLIFFORD H. POPE, GEORGE B. RABB, ERNEST E. WILLIAMS.

These nominees were elected unanimously.

The following resolution was passed unanimously:

"Whereas, the national seashore areas available to public use are rapidly vanishing, and

"Whereas, Padre Island is the longest unspoiled stretch of seashore remaining in the United States, and

"Whereas, testimony at a federal hearing held in Corpus Christi presented indisputable evidence of overwhelming public support for the establishment of a proposed 88 mile National Seashore on Padre Island, and

"Whereas, the 88 mile proposal is adequate both for preservation of the natural scenic, recreational and scientific values of the island and for sufficient commercial development at both ends of the island,

"Therefore, be it resolved that the American Society of Ichthyologists and Herpetologists, an organization of professional biological scientists representing all geographical regions of the United States, does hereby endorse the proposed 88 mile National Seashore on Padre Island, and

"Be it further resolved that legislation be passed with all due speed in order to preserve this aesthetically and scientifically valu-

able natural beach for a distance of not less than 88 miles."

After considerable discussion on the proposed poisoning of the Green River above the Flaming Gorge Dam, a resolution registering in principle the Society's strongest objections to large-scale, non-specific poisoning of the Green River was passed unanimously. DR. ROBERT R. MILLER was asked to draft a resolution for transmission to the proper authorities. (This resolution has now been drafted, and is available from the Secretary.)

The President announced that the name of the Committee on Traffic in Venomous Reptiles was changed to the Committee on Traffic in Cold-Blooded Vertebrates and then read the following committee assignments:

Nominating Committee: RICHARD HIGHTON, Chairman, JOSEPH R. BAILEY, W. RALPH TAYLOR, and HOWARD E. WINN.

Common Names of Fishes Committee: REEVE M. BAILEY, Chairman, ERNEST A. LACHNER, CASIMIR C. LINDSEY, C. RICHARD ROBINS, PHILIP M. ROEDEL, W. B. SCOTT, and LOREN P. WOODS.

Translation of Biological Literature Committee: CARL GANS, Chairman, ROBERT P. DEMPSTER, DONALD P. DESYLVA, TERUYA UYENO, and VLADIMIR WALTERS.

Traffic in Cold-Blooded Vertebrates Committee: HERNDON G. DOWLING, Chairman, ROGER CONANT, EARL S. HERALD, SHERMAN A. MINTON, JR., and CHARLES E. SHAW.

Local Committee for Washington Meeting: DANIEL M. COHEN, Chairman.

Zoological Nomenclature Committee: GILES W. MEAD, Chairman, SHERMAN F. BLEAKNEY, BAYARD H. BRATTSTROM, CLARK F. HUBBS, HOBART M. SMITH, and ROYAL D. SUTTKUS.

Special Committee for the 50th Anniversary (1963): M. GRAHAM NETTING, Chairman, HELEN T. GAIGE, COLEMAN J. GOIN, CARL L. HUBBS, Managing Editor of COPEIA, Secretary of ASIH, and Treasurer of ASIH.

Herpetological Check List Committee: WILLIAM J. REIMER, Chairman, HERNDON G. DOWLING, ALAN E. LEVITON, WILFRED T. NEILL, PHILIP W. SMITH, HOBART M. SMITH, and RICHARD G. ZWEIFEL.

The President asked the members present to indicate the best time for our annual meetings. There were 23 members who preferred spring vacation time, while 34 would prefer June meetings.

A motion to commend and thank the Committee on Common Names of Fishes for the excellent work done and the great amount of time spent in the preparation of the list was unanimously passed.

DR. ARTHUR D. HASLER announced that the fifteenth International Congress of Limnology will be held at Madison, Wisconsin in August of 1962, and interested members were invited to consider participation.

DR. RICHARD BALDAUF suggested that the Society investigate the possibility of putting ichthyology and herpetology sections of the Zoological Record on IBM punch cards. The President was directed to appoint a committee to look into the problem.

The meeting was adjourned at 3:30 P. M.

ANNUAL DINNER

The annual dinner was held at the Commodore Perry Hotel on Sunday, April 2. CARL D. RIGGS performed the duties of toastmaster. The Stoye Prizes for the best student papers in ichthyology were presented to KAREL F. LIEM, University of Illinois, first prize, for his paper "Tetrapod parallelisms in the functional anatomy of the blood vascular system of *Fluta alba* (Zuiew) (Symbranchiformes)," and to MORGAN E. SISK, Oklahoma State University, second prize, for the paper "Comparative morphology of the Weberian apparatus in *Notropis* and *Dionda*." The Stoye Prizes in herpetology were awarded to ARNOLD G. KLUGE, University of Southern California, for the paper "Interspecific relationships in the gecko genus *Coleonyx*," and to DANIEL A. BELKIN, University of Florida, for his paper, "Experiments in the respiratory physiology of diving turtles."

The Chairman of the Resolutions Committee, E. PETER VOLPE, read the following resolutions:

"Whereas, the 41st Annual Meeting of the American Society of Ichthyologists and Herpetologists held at the University of Texas, from March 30 to April 3, inclusive, is being successfully concluded, and, whereas, under the aegis of President GEORGE A. MOORE, it has been one of the most successful of meetings,

"Be it therefore resolved that the American Society of Ichthyologists and Herpetologists expresses deep appreciation and high commendation to the local committee, DR. W. FRANK BLAIR, Chairman, whose meticulous planning has provided the Society the numerous benefits and accommodations of this meeting. Heartfelt thanks are extended to the following local senior committee members: MR. W. K. DAVIS, Chairman of Saturday field trips; DR. CLARK HUBBS, Chairman of registration and facilities; DR. WILLIAM N. MCFARLAND, Chairman of post-meeting trips; and MR. MARION TOOLE of the Texas Game and Fish Commission, Chairman of banquets; and to 26 students and employees of the local junior committee, notable among them being MR.

WAYNE H. MCALLISTER and MR. KENNETH RAY PORTER.

"Be it further resolved that very special thanks be given to DR. AND MRS. W. FRANK BLAIR and the senior local committee members, hosts extraordinaires to the Board of Governors, whose knowledge of the better things of life, graciously provided at the attractive home of the Blairs, enabled the said Governors to endure the lengthy meeting that followed.

"Be it further resolved that the Society's appreciations be conveyed to DR. HARRY HUNTT RANSOM, Chancellor of the University of Texas, and his associates, for the physical facilities they have made available to us; to the San Marcos Sportman's Club for preparing and serving the delectable outdoor luncheon; and to the Texas Herpetological Society for their active share in the enlightening exhibit of the herpetofauna of the great State of Texas.

"Be it further resolved, on behalf of the 275 members and innumerable members' wives from thirty-one states, two Canadian provinces, and one Mexican state, who registered attendance at this meeting, that an assertion be made of personal awareness of having attended a most interesting and beneficial meeting."

"Whereas, the American Society of Ichthyologists and Herpetologists found itself without an editor-in-chief for *Copeia* during the year 1959, and

"Whereas, DR. PHILIP W. SMITH was pressed into service for that assignment, and

"Whereas, he served with efficiency and dispatch despite his normal heavy load of activities,

"Be it therefore resolved, that the American Society of Ichthyologists and Herpetologists owes a debt of gratitude to PHILIP W. SMITH for his devotion to the Society's journal *Copeia* and for the patience and care with which he attended the many duties attendant upon the office."

Motion pictures on behavior, taken by IRENAUS EIBL-EIBESFELDT, of the Max-Planck Institute Für Verhaltensphysiologie, Seewiessen, Germany, were shown as the principal entertainment of the evening.

The annual group photograph may be ordered from Studtman Photo Service, No. 1, 222 West 19th Street, Austin, Texas. Cost of the photograph is $1.50. A list of names will be supplied with each copy.

Due to the high costs of publication of our journal, this report has been confined to the business transacted which must be communicated to the Society as a whole. A few copies of the program are available to anyone who wishes to have a list of the papers presented.—JAMES A. PETERS, SECRETARY.

AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS
Board of Governors
1961

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EDITORIAL NOTES AND NEWS

Foreign News

THE following herpetological and ichthyological news from Argentina and Chile was sent to us by DR. JOSÉ M. CEI, Instituto de Biologia, Universidad Nacional de Cuyo, Mendoza, Argentina.

At Mendoza's Instituto de Biologia, DR. F. BERTINI, in collaboration with DR. CEI and others, is investigating physicochemical properties of hemoglobin in neotropical amphibians using electrophoretic methods. DRS. CEI and V. G. ROIG are studying the Argentina Mesopotamian batrachians and the zoogeographical relations between Misiones Territory and the nearest Brazilian districts. Cytogenetic research on neotropical anurans is being done by DR. CEI and DR. F. A. SAEZ of Montevideo, Uruguay. DR. CEI is also working with DR. V. ERSPAMER of the University of Parma, Italy, on the biochemistry of the skin of neotropical frogs.

PROF. OSVALDO REIG of the University of Buenos Aires is supervising the study of fossil (Mesozoic and Cenozoic) and recent herpetofaunas of western Argentina at the Laboratorio Batracologia, Instituto M. Lillo, Tucumán. In Buenos Aires, DR. REIG and collaborators are investigating the osteological characters of many forms of bufonid and leptodactylid neotropical frogs. DR. A. BARRIO is studying the biological and systematic characteristics of *Crotalus* venom.

At Museo Bernardino Rivadavia, Buenos Aires, DR. J. M. GALLARDO is studying the taxonomic status of Argentine and neotropical batrachians. Museo Bernardino Rivadavia's ichthyologists, DRS. A. NANI and F. GNERI, are organizing a new marine biological station on the Atlantic coast. They are also doing economic research on the Atlantic fauna.

DR. R. DONOSO BARROS of Instituto de Biologia, Universidad de Chile, Santiago de Chile, is working on a revision of *Urostrophus* and on a monograph of Chilean lizards and snakes. At Santiago's Museo Nacional, DR. N. BAHAMONDE is studying the Pacific fauna of southern Chile.

Revision of the taxonomic status of Chilean fishes is being continued by DR. F. DE BUEN of Estación Biologia Marina, Universidad de Chile, Viña del Mar-Valparaiso.

PROF. J. VALENCIA, Universidad Catolica de Chile, Santiago de Chile, is working on interspecific hybridization in neotropical species of *Bufo*. Other studies on normal and experimental development of *Pleurodema* are being pursued.

DR. JANIS R. ROZE, Universidad Central de Venezuela, has recently written us about herpetological activities in Venezuela. At the Universidad Central, MISS HAYDÉE SOLANO is studying Venezuelan amphibians and Gekkonidae, the latter project being a joint effort with DR. ROZE. MR. BRAULIO ORFJAS, who has recently joined the university staff from the Museo de Historia Natural de Montevideo, is doing research on South American snakes. PROFESSORS A. GAMERO and M. MONTBRUN are investigating the embryology of various Venezuelan amphibia, including *Pipa pipa* and *Pleurodema brachyops*. DR. ROZE

is continuing his studies on coral snakes and last year began a field investigation of the ecology of *Podocnemis expansa* in the middle Orinoco.

DR. ROZE also tells us that a Sección de Ictiologia y Herpetologia has been formed in the Sociedad Venezolana de Ciencias Naturales. The Sección, affiliated with the Sociedad Suramericana de Ictiólogos y Herpetólogos, has as officers: J. A. ROZE, President; H. SOLANO, Secretary; and R. LANCINI, Public Relations Officer.

PROFESSOR PAUL V. TERENTJEV, Department of Vertebrate Zoology, Leningrad, W.O., University, author of the new book *Herpetology* (price 86 kopecs), has sent us the following information concerning herpetology in the U.S.S.R.

The largest collection of reptiles and amphibians is in the Leningrad Zoological Museum of the Academy of Sciences, U.S.S.R. The second largest is in the Zoological Museum, Moscow University, and the third in Leningrad University. There are herpetological collections in other universities and local academies of science.

As to personnel, ASS'T. PROFESSOR L. I. KHOSATZHY, Leningrad University, is studying fossil and recent Chelonia. In Moscow, PROFESSOR A. G. BANNIKOV is working on field ecology and W. CHERNOMORDIKOV on experimental ecology. A young zoologist, W. I. GARANIN, Kazan, is studying the morphology, ecology, and taxonomy of the local herpetofauna. At Kiev the local herpetologists are W. I. TARASHCHUK (now working mostly on paleontology), J. I. PASHCHENKO, and N. N. SHCHERBAK, a specialist on Geckkonidae. Herpetologists in the Caucasus are I. S. DAREVSKY (Erivan) who works on Lacertidae, S. B. PAPANJAN (Erivan) who is studying *Bufo*, and PROFESSOR A. M. ALEKPEROV, vice-rector of Azerbaijan University. At Sverdlovsk a former pupil of PROF. TERENTJEV, PROF. S. S. SCHWARZ, is doing interesting work on the biometry of reptile viscera. Also at Sverdlovsk is another pupil of PROF. TERENTJEV, W. ISHCHENKO, who is studying the ecology of *Hynobius*. O. P. BOGDANOV is doing exploratory field work near Tashkent.

Snake poison and poisoning are the subjects of study of Z. S. BARKAGAN (a physician at Barnaul), G. I. ISHUNIN (Genichesk), and F. Talysin. PROF. VOITKEVITSCH (Voronezh) studies teratological frogs. Parasitology of reptiles and amphibians is being studied by F. S. MARKOV (Stalingrad), M. DUBININA (Leningrad), A. M. ANDRUSHKO (Leningrad) and others.

Besides these people, there are a number of "occasional" herpetologists and some herpetologists who have retired. Among the last are W. N. ROSTAMBEKOV (Tiflis), S. T. ZAREVSKY (formerly at Leningrad, now in Kazan), and N. A. BOBRINSKOI (Moskow). K. P. PARASKIV and N. W. SHIBANOV recently died. S. A. CHERNOV has been forced by serious illness to retire from his position as Curator in the Leningrad Zoological Museum.

In PROF. TERENTJEV's opinion the most prominent recent herpetological works are:

K. P. PARASKIV, 1956 "Reptilia of Kazakhstan", 228 pp.

S. A. CHERNOV, 1959 "Reptilia of Tadzhikstan", 204 pp.

W. I. TARASHCHUK, 1959 "Reptilia and Amphibia of Ukraine", 246 pp.

O. P. BOGDANOV, 1960 "Reptilia and Amphibia of Uzbekistan", 260 pp.

PROF. TERENTJEV modestly refrained from listing:

P. V. TERENTJEV, 1950 "The frog", 345 pp.

———, 1961 "Herpetology", 335 pp.

P. V. TERENTJEV and S. A. CHERNOV, 1949 "Catalog of reptiles and amphibians", 339 pp.

DR. WILLIAM E. RICKER, editor of the Fisheries Research Board of Canada, writes of a recent issue of the Soviet fishery magazine "Rybnoe Khoziaĭstvo" (1961, No. 5) which carries news that PROFESSOR F. I. BARANOV has passed his 75th birthday amid the congratulations of his former students and colleagues. PROFESSOR BARANOV, now retired and living in Moscow, was up to a few years ago professor in the Mikoyan Technical Fisheries Institute of Moscow (now of Kaliningrad).

PROFESSOR BARANOV's theoretical work concerning the biological structure of fish stocks, and the effects of fishing on them, has become well known in America. Some important applications of Baranov's theoretical work to fish populations is given in Dr. Ricker's book "Handbook of computations for biological statistics of fish populations" (see *Copeia*, 1960, *(4):385–6*). Still little known here, but highly esteemed in the USSR, are his works on the theory and design of fish nets of various types, and the mechanics of fishing with trawls, etc.

Because BARANOV the man has been a shadowy and almost legendary figure among western fishery biologists, the article referred to has been translated in full by Dr. Ricker below:

PROFESSOR FËDOR ILICH BARANOV, Honorary Deyatel of Science and Technology and Doctor of Technical Sciences, recently celebrated his 75th birthday. The scientific and pedagogical activities of PROFESSOR BARANOV are intimately associated with the history of the development of the science of commerical fisheries. F. I. BARANOV

was born on April 1, 1886. In 1910 he graduated from the Faculty of Marine Architecture of the former St. Petersburg Polytechnic Institute, with the degree of Marine Engineer [Morskoi Inzhiner]. In 1912 BARANOV began work as a specialist on fishery affairs in the Department of Agriculture.

In 1915 the Russian Fisheries Society awarded BARANOV its Veshniakov Medal, for his work on the technique of fishing with various kinds of gear.

In 1915 BARANOV was appointed Professor, to occupy the new Chair of Commercial Fisheries which was established in the same year in the Department of Fish Culture at the Moscow Agricultural Academy.

In 1935 the VAK All-Union Committee on Advanced Technical Education awarded Professor Baranov the academic degree of Doctor of Technical Sciences without defense of a dissertation.

PROFESSOR BARANOV is the originator of theoretical work in the field of commercial fishing, and is widely known for his works dealing with fisheries in the USSR and abroad. It is difficult to overestimate the importance of Professor Baranov's contribution in working out the theoretical aspects of commercial fishing. He developed the theory of fishing and construction of fishing gear set forth in his monograph "Theory and Design of Fishing Apparatus". Previous to the appearance of Baranov's publication, work on the technique of fishing in our country and abroad was strictly of a descriptive and statistical character.

F. I. BARANOV has produced more than 100 published works, of which 15 are basic scientific papers concerning the theory and practice of commercial fishing, 18 are popular books on the same subject, and the remaining 70 or so are articles in specialized scientific journals and collections.

The principal works by PROFESSOR BARANOV may be divided into three groups.

I. Those relating to the initial period of his scientific activity (1912–1914) concerned commercial fishing apparatus and are descriptive in nature.

II. The original work "On the Question of the Biological Basis of Fisheries", printed in 1918, set off a large-scale discussion in USSR fishery literature and called forth comments in the foreign press.

III. His two principal works: "Techniques of Commercial Fishing" and "Theory and Design of Fishing Apparatus", which have been regarded as establishing a new branch of applied science—the science of commercial fishing—were published in 1933 and 1940, and were revised and reissued in 1948 and 1960.

For more than 55 years PROFESSOR BARANOV devoted himself to pedagogical work. During this time he taught hundreds of commercial fishing specialists and scores of aspirants for the advanced degree of 'Kandidat' of Technological Sciences.

BARANOV's services have been highly regarded by the Soviet authorities: he was awarded the Order of Lenin, and has been granted the complimentary title of Honorary Deyatel of Science and Technology.

On his 75th birthday, workers in the fishing industry and numerous scientists warmly congratulated their esteemed colleague and wished him happiness, health, and strength for additional fruitful scientific activity.

A scientific article on the differences of growth in Siberian and Alaskan salmon by DR. DONALD E. BEVAN, research associate professor of Fisheries at the University of Washington, has been published in a Russian fisheries journal.

PROFESSOR BEVAN'S article is the first by an American fisheries scientist to appear in a Soviet scientific journal since before World War II. It is in the May issue of "Ichthyology," published in Moscow. PROFESSOR BEVAN wrote the paper while in the Soviet Union during the 1959–60 year under a Soviet-American student exchange program.

In the article, PROFESSOR BEVAN reports on the striking differences in rates of growth between the two types of salmon. The findings are useful in identifying salmon of Asian or Alaskan origin in the mid-Pacific.

During his visit in the Soviet Union, his headquarters was in Moscow, and he traveled widely throughout the country, visiting various institutes and universities involved in fisheries training and research.

DR. HAJIME FUKADA, Assistant Professor of Zoology at Kyoto Gakugei University, received the Rigaku-Hakushi (D.Sc.) degree from Kyoto University. His thesis was "Biological Studies on the Snakes."

Translation Committee

THE committee on the translation of biological literature from the slavic and oriental languages asks A.S.I.H. members to assist by furnishing the following information:

1. Lists of any, particularly recent or obscure, items from these languages that are of interest,

pertinent to our areas and might merit consideration for translation.

2. Information on individuals who have translations or similar projects in process and may need assistance with this or in the dissemination of the results.

3. Statements on any unpublished or otherwise unavailable translations in your files.

4. A statement of items translated during the last few years and available in printed, mimeographed or micro film form. The committee will attempt to mimeograph a list of these and have it ready at the next annual meeting.

Please address all communications to CARL GANS, *Department of Biology, The University of Buffalo, Buffalo 14, New York.*

Death Notices

DONALD R. CRAWFORD, SR., and early contributor to *Copeia*, former instructor at the College of Fisheries, University of Washington, and an employee of the old U. S. Bureau of Fisheries, died of cancer on September 27, 1960 in Baltimore, Maryland. He was one of the first four graduates of the College of Fisheries and took a Masters Degree at the University. As an ichthyologist and fishery biologist he contributed a number of short ecological papers, some in collaboration with DR. C. M. BREDER, JR. He worked extensively with the feeding habits of wild and hatchery fish, and was active in fisheries work during the 1920s in Florida, District of Columbia, Montana, and Washington State. Circumstances forced him out of the profession during the depression of the 1930s and he never returned to it on a full-time basis. Within the last decade during his retirement he has been active as curator of the Department of Marine Research at the Natural History Society of Maryland, and has published several fish articles in the *Maryland Naturalist* and *Aquarium Magazine.*

MR. GEORGE VANDERBILT, founder of the George Vanderbilt Foundation, died in San Francisco on June 24.

XVI International Congress

DR. GAIRDNER B. MOMENT, Secretary General of the XVI International Congress of Zoology, Washington, D. C., 21–27 August 1963, has requested voluntary financial help from members of various societies. For many members of ASIH this may be the only time we can participate in such an international meeting. It is a rare opportunity and reflects honor to Zoologists of the United States. Contributions, large or small, may be sent to Alexander Wetmore, Treasurer, NAS-NRC, 2101 Constitution Avenue, Washington 25, D.C. Checks should be made payable to the National Academy of Science, with a notation that they are for the XVI Congress.

News Notes

FRANCESCA LA-MONTE, Associate Curator of Fishes in the American Museum of Natural History, retired on July 31. She expects to stay in New York and will be working on a paper, parts of which will contribute to the section on Xiphiidae and Istiophoridae in a future volume of "Fishes of the Western North Atlantic."

MR. T. D. SCOTT, Curator of Fishes in the South Australia Museum (at Adelaide) is preparing a handbook on South Australian Fishes.

DR. PER F. SCHOLANDER of Scripps Institution of Oceanography, widely known for his researches on the physiology of fishes and other organisms, has been elected a member of the National Academy of Sciences.

DR. JOHN C. BRIGGS is leaving the University of British Columbia for the position of ichthyologist at the Institute of Marine Science of the University of Texas, at Port Aransas, Texas. During the summer of 1961 he taught the ichthyology course at Hopkins Marine Station of Stanford University at Pacific Grove, California.

The Ohio Herpetological Society held its fourth annual meeting June 10–11, 1961, at the Cincinnati Museum of Natural History. With CHAIRMAN KRAIG K. ADLER presiding and after a welcome by Museum Director Ralph Dury, the following papers were presented: "Notes on the ecology of the northern copperhead," DR. GEORGE T. MCDUFFIE; "Reminiscences of a herpetologist," ROGER CONANT; "The amphibians of Kentucky," THOMAS C. FULLER; "The distribution of *Natrix* and *Thamnophis eques* in Mexico," ROGER CONANT. Abstracts of the papers were published in *Journal of the O.H.S.*, vol. 3, no. 2.

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tern," 1961. W. H. Freeman and Company, San Francisco. 555 pp. $10.00.

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Grandison, Alice G. C. and Edwards, Marcia A. "Amphibia", 1957. *Zoological Record*, Vol. 95, Sect. 16a, 1958. The Zoological Society of London, 100 pp. 6 s.

Schmidt-Nielsen, Knut. "Animal Physiology," 1960. Prentice-Hall Foundations of Modern Biology Series, Prentice-Hall, Inc., Englewood Cliffs, New Jersey. 118 pp. $1.50.

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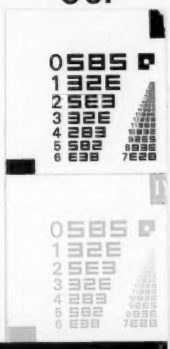
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